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Vol. LXX JULY, 1919 No. 1

ANNALS of SURGERY

A Monthly Review of Surgical Science and Practice

Edited by
LEWIS STEPHEN PILCHER, M.D., LL.D.
of New York

With the Collaboration of
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SIR W. WATSON CHEYNE, C.B., F.R.S. of London

CRANIOPLASTY 1
ALEXANDER PRIMROSE, C.M. . . . . TORONTO
CLAMP FOR OSTEOPLASTIC CRANIOTOMY 21
ERNEST SACHS, M.D. . . . . ST. LOUIS
THE RESULTS OF SPLENECTOMY IN THE ANÆMIAS 22
WILLIAM J. MAYO, M.D. . . . . ROCHESTER
THE TREATMENT OF GUNSHOT WOUNDS OF THE CHEST 30
ELLSWORTH ELIOT, JR., M.D. . . . . NEW YORK
THE DELAYED OR LATE EXTRACTION OF INTRATHORACIC PROJECTILES BY THE METHOD OF PETIT DE LA VILLÉON 37
ROBERT G. LE CONTE, M.D. . . . . PHILADELPHIA
THORACIC FISTULA AND CHRONIC EMPYEMA 43
HOWARD LILIENTHAL, M.D. . . . . NEW YORK
EMPYEMA 49
JOHN STEWART RODMAN, M.D. . . . . PHILADELPHIA
THE TREATMENT OF EMPYEMA 55
JOHN A. HARTWELL, M.D. . . . . NEW YORK
FOREIGN BODIES IN THE STOMACH 60
RANDOLPH WINSLOW, M.D. . . . . BALTIMORE
INGUINAL HERNIA 65
FRANZ TOREK, M.D. . . . . NEW YORK
THE TRANSPLANTATION OF THE RECTUS MUSCLE OR ITS SHEATH . 81
JOSEPH COLT BLOODGOOD, M.D. . . . . BALTIMORE
STRANGULATED AND IRREDUCIBLE HERNIÆ 89
EDWARD H. RISLEY, M.D. . . . . BOSTON
ROENTGEN EXAMINATION OF THE ABDOMINAL ORGANS 95
ARTHUR STEIN, M.D., AND WILLIAM H. STEWART, M.D. . . . . NEW YORK
INSTRUMENTS FOR PROCURING AUTOGENOUS BONE BOLTS AND KEYS 101
WILLIAM LISLE BELL, M.D. . . . . OAKLAND
THE USE OF AUTOGENOUS BONE GRAFTS 105
MARK LEWIS EMERSON, M.D. . . . . OAKLAND
THE TREATMENT OF ACUTE GASTROMESENTERIC ILEUS 107
ALBERT PAUL CONDON, M.D. . . . . OMAHA
THE NO-FLAP OR GUILLOTINE AMPUTATION 111
JOHN H. GIBBON, M.D. . . . . PHILADELPHIA
TRANSACTIONS OF THE PHILADELPHIA ACADEMY OF SURGERY . . . 113
STATED MEETINGS HELD MARCH 13, 1919, AND APRIL 7, 1919.

J. B. LIPPINCOTT COMPANY, PUBLISHERS
MONTREAL PHILADELPHIA LONDON

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767

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ANNALS of SURGERY

VOL. LXX JULY, 1919 No. 1

CRANIOPLASTY. THE VALUE OF A GRAFT OF BONE, CARTILAGE OR FASCIA IN THE CLOSURE OF CRANIAL DEFECTS CAUSED BY WOUNDS IN WAR *

A STUDY OF THE RESULTS OBTAINED IN A SERIES OF FORTY-TWO OPERATIONS

BY ALEXANDER PRIMROSE, C.M.

OF TORONTO, CAN.

COLONEL, C. A. M. C., SURGEON IN CHARGE OF THE MILITARY CLINIC AT THE TORONTO GENERAL HOSPITAL

THE degree of disability resulting from the existence of a defect in the bony vault of the cranium varies within wide limits and is dependent upon a number of factors, including the size of the opening, the amount of scar tissue, and the damage sustained by the meninges of the brain as well as by the brain substance itself. There is also a certain psychic factor which has to be reckoned with in estimating the disability: the mental attitude of the wounded man may tend to give one an exaggerated conception of his trouble as indicated by the subjective symptoms or, in exceptional circumstances, the reverse may be the case.

The series of cases described in the present paper consists of 42 cranioplasties performed in 38 patients. The treatment was carried out in the military wards of the Toronto General Hospital. The writer was in charge of this special clinic and had as members of his staff Lt. Col. Gilmour, Major G. E. Wilson, Major Gaby and Captain Shenstone. Most of the operations were done by these officers.

Age.—The youngest patient operated upon was 19 years of age, the oldest 40 years of age; the average being 26.5 years. It will thus be seen that they were young men, most of them healthy and vigorous, capable of withstanding the immediate effects of an extensive operation satisfactorily and possessing excellent reparative power.

Region of Cranium Affected.—The portion of the skull in which the gap was located is indicated in the following table:

Frontal	12
Frontoparietal	8
Parietal	13
Occipitoparietal	6
Occipital	2
Temporo-occipital	1
Total	42

* Read before the American Surgical Association, June 16, 1919.

The Cause of the Wound.—All the patients received their wounds on active service overseas as follows:

Bullet, shrapnel, etc.	36
Aeroplane bomb	1
Shell concussion causing unconsciousness and fracture due to fall	1
Hit by sandbag	1
Hit by aeroplane propeller	2
Pyæmic abscess and necrosis	1
Total	42

Time elapsing between the date of receiving wound and the date of the operation of cranioplasty:

1 case	50 months
1 case	46 months
5 cases	22 to 32 months
11 cases	10 to 16 months
20 cases	4 to 9 months

38 cases, average 13.2 months.

The symptoms complained of by individual patients varied in proportion to the extent of his wound and the region of the brain involved in the injury. Thus where the so-called "silent" areas of the brain were involved the symptoms would be subjective in character only, while in others there would be evidence of an organic lesion, such as hemiplegia, aphasia, defective vision, loss of hearing, loss of smell, etc.

We have made a careful analysis of the symptoms and the results obtained by a successful cranioplasty in the whole series of 42 operations. This seemed to us the best way of estimating from our experiences the benefit, or otherwise, of undertaking an operation for the closure of the cranial gap. The results are as follows:

SYMPTOMS AND RESULTS OF OPERATION

Headache.—Nearly all cases suffered from headache. There were four exceptions.

Case I.—A man, aged twenty-nine, wounded in the left parietal region in August, 1918, followed by complete hemiplegia (motor and sensory) showed steady improvement after the removal of a F.B. eleven days after the wound was received. He suffered no disability on coming to our clinic save a sense of insecurity: he had no headache and no dizziness: he wished an operation for cosmetic purposes and for safety. A bone graft was done on February 2, 1919, six months after receiving the wound, with excellent results.

Case II.—A man, aged twenty-six, with a hiatus 2.5 cm. by 2 cm. in

left temporo-occipital region. He had no headache and no dizziness but felt nervous and afraid. He was also subject to occasional fits of unconsciousness when excited or fatigued. There had been right hemiplegia immediately after the wound was received. Some weakness of right arm and leg still remain. A cartilage graft was inserted January 15, 1919, one year after receiving the wound. The result has been entirely satisfactory and he no longer suffers from fits of unconsciousness.

CASE III.—A man, aged twenty-four, with right parietal gap in the skull. A foreign body had perforated his steel helmet and struck a glancing blow on the skull. He became partially hemiplegic, following the wound which was received August 27, 1918. At the time the cranioplasty was performed, January 23, 1919, five months after receiving wound, he had no headache but had some dizziness. A bone graft was inserted and he recovered: he lost his dizziness and secured a sense of safety and security which he lacked before operation.

CASE IV.—A man, aged twenty, received a wound (October 20, 1917) in left parieto-occipital region. He suffered no headache. He had obviously had some degree of hemiplegia after receiving the wound and on admission to our clinic had weakness of the right hand and leg. A gap 7 by 4 cm. was closed by cartilage graft (May 29, 1918). Subsequent to the operation he had a certain amount of headache. The hiatus remained successfully closed. It is worthy of note that all cases free from headache were wounds in the parietal region involving the Rolandic area and suffering hemiplegia.

Results of Operation on Headache.—As a rule headache was completely relieved by a successful cranioplasty. The exceptions were as follows:

CASE I.—A man, aged twenty-four, with a double cranial defect had his first operation for closure of a frontal lesion six months after the wound, and a second operation for closure of an occipital defect two months subsequently. These were successful cartilage grafts. The headaches were only slightly relieved.

CASE II.—A man, aged twenty, with a left parietal lesion had a successful cartilage graft seven months after the wound. The headache was greatly relieved but not entirely.

CASE III.—A man, aged thirty, with a large right frontoparietal lesion had a cartilage graft twenty-four months after wound. The headache persisted.

CASE IV.—A man, aged twenty-two, with a right frontal lesion had a cartilage graft seven months after wound. His headache was, if anything, worse than before.

CASE V.—A man, aged twenty-nine, with a left parietal defect had cartilage graft ten months after wound. The headaches were relieved but not entirely abolished.

CASE VI.—A man, aged twenty-three, with a right parietal defect had cartilage graft twenty-two months after wound. There was no improvement in headaches.

CASE VII.—A man, aged thirty-three, with right parietal defect

had bone graft four months after wound. The headaches persisted as before.

CASE VIII.—A man, aged twenty-seven, with parieto-occipital defect had bone graft seven months after wound. The headaches continued.

CASE IX.—A man, aged twenty, with parieto-occipital defect had cartilage graft seven months after wound. The headache was largely relieved but not wholly.

CASE X.—A man, aged thirty-one, with right parietal defect had cartilage graft twenty-two months after wound. His headaches and dizziness were not relieved.

The question of relief or otherwise from headache was not dependent upon the length of time which elapsed from the time of the wound until the defect was closed. Thus a man suffering constant headache was relieved by a cranioplasty after a lapse of fifty months, while in another case there was no relief of headache after a lapse of four months.

Dizziness.—In most instances if a man had no headache he had no dizziness, but, as a fact, in the whole series of 42 cases there were only four cases free from either headache or dizziness. The dizziness was a very distressing symptom. The conditions under which it developed varied:

Thus one man, aged twenty-two, with a left parietal gap, got dizzy when he went to bed and suffered a very disagreeable sensation as if the bed were upsetting. Another man, aged twenty-three, with a frontal gap 5 cm. by 3.5 cm. would occasionally fall from dizziness but would not lose consciousness. Another man, aged thirty-three, with a posterior parietal gap (4 cm. by 4 cm.) felt dizzy when lying down. On the other hand, a man, aged thirty-two, with a left frontal gap (2.5 cm. by 5 cm.) was compelled to lie down for relief when he got dizzy. Another man, aged twenty, with a parietal gap (5 cm. by 5 cm.) would sometimes fall because of dizziness. This man had worn rubber heels in order to prevent jarring and by this means obtained considerable relief from his headache and giddiness.

The headache and dizziness would be aggravated by exertion or fatigue, and would often be induced by turning the head rapidly.

Results of Operation on Dizziness.—The relief of dizziness by operation was more pronounced than that of headache. The exceptions were few.

CASE I.—A man, aged twenty-four, with a double lesion, one in the parietal and one in the occipital region, had a bone graft in the parietal gap five months after the wound and a cartilage graft in the occipital gap four months subsequently. The attacks of dizziness were much less frequent, but they were not entirely relieved.

CASE II.—A man, aged thirty-one, with a right parietal lesion had a cartilage graft twenty-two months after wound. His dizziness and headache were not relieved.

Loss of Memory.—This was recorded in seven specific instances, but there were doubtless others where the history is incomplete. It was markedly the case that the loss of memory was for recent events, while incidents of older date were comparatively readily recalled. The regions involved were as follows: (1) Fronto-parietal; (2) left parieto-occipital; (3) double = left parietal and left occipital; (4) left parietal; (5) frontal; (6) right frontal; (7) parieto-occipital.

Results of Operation.—The effect of operation was naturally not immediately apparent, but in some instances it was noted after a lapse of some weeks or months the memory was much improved.

Deafness.—Deafness was recorded in four instances. These were gaps recorded as follows: (1) Left frontoparietal; (2) left parietal; (3) left temporo-occipital; (4) left parietal.

The results of operation were not appreciable.

Noises in the Ear.—There were two cases, one a gap in frontoparietal and the other in a similar locality.

The result of operation was not appreciable.

Defective Vision.—There were six cases in which vision was affected.

Case I.—A man, aged twenty-four, with a double lesion, one gap (5 cm. by 3 cm.) in the frontal, and another gap (3 cm. by 3 cm.) in the occipito-parietal region, complained that vision was blurred.

Case II.—A man, aged twenty-four, with double lesion, one gap in the left parietal and one in the left occipital region, had homonymous hemianopsia with 75 per cent. disability.

Case III.—A man, aged thirty-two, with a left parietal lesion complained of "poor vision."

Case IV.—A man, aged twenty-two, with right frontal lesion complained of vision becoming blurred.

Case V.—A man, aged thirty-three, with a parieto-occipital lesion had right-sided homonymous hemianopsia.

Case VI.—A man, aged twenty-five, with left frontal lesion suffered from "eye strain."

The Results of Operation.—No improvement was apparent in any of these cases.

Aphasia.—There were five cases in which aphasia was noted in varying degree:

Case I.—A man, aged twenty-six, with a left frontoparietal lesion had difficulty in speech and was at first unable to read: he gradually regained the power of reading.

Case II.—A man, aged twenty-six, with a left anterior parietal lesion had difficulty in speaking.

Case III.—A man, aged twenty-two, with a right frontal lesion could speak and read as well as formerly, but had some difficulty in recalling names.

CASE IV.—A man, aged twenty-two, with a left parietal lesion had difficulty in putting thoughts into words.

CASE V.—A man, aged thirty-three, with a parieto-occipital lesion had lost at first the power of speech. This gradually improved, but his speech was still slow twenty-nine months after the reception of wound.

Results of Operation.—There were no observations to suggest that the operative procedure had any effect upon the aphasic condition. Many of these cases showed a slow process of recovery before the operation was undertaken and this continued subsequent thereto.

Hemiplegia.—There were 15 cases of hemiplegia in varying degrees. Unfortunately, no accurate clinical record is available of the precise extent or degree of the hemiplegia which supervened after receiving the wound. Our patients on admission to our clinic exhibited such symptoms as exaggerated reflexes, spastic gait, anæsthesiæ, Babinski's sign and certain contractures.

CASE I.—A man, aged twenty, with a left parieto-occipital lesion had weakness of the right hand and leg, which was observed for two months after receiving wound: this had almost entirely cleared up when he came to our clinic seven months after the wound.

CASE II.—A man, aged twenty-four, with double lesion, left parietal and left occipital, had immediate weakness of the right arm and leg: this continued when examined nine months after the wound.

CASE III.—A man, aged twenty-six, with a left parietal lesion had right hemiplegia which cleared up, but weakness still continued thirteen months after the wound.

CASE IV.—A man, aged thirty, with a left occipital lesion had the right leg partially paralyzed.

CASE V.—A man, aged twenty-six, with a left temporo-occipital lesion was trephined the day after being wounded. He was paralyzed in the right arm and the right leg. When coming to our clinic twelve months after being wounded he walked with a limp and had weakness of the right leg. There was also marked weakness of the right hand. Two months after repair of the cranial gap the record states that there was marked improvement in function in the leg and hand.

CASE VI.—A man, aged twenty-six, with a left frontoparietal lesion had a fit immediately after the injury and was paralyzed in the left side. He was unconscious for three weeks, a fortnight later the paralysis cleared up on the left side and the right side became paralyzed. This subsequently cleared up almost entirely, but after a cartilage graft, fifteen months subsequent to the wound, right hemiplegia again developed and he was readmitted after a lapse of six months, suffering also from severe Jacksonian epilepsy. The graft was removed and a fascial graft substituted after free dissection of the scar tissue. The paralysis completely cleared in ten days and the fits ceased to recur.

CASE VII.—A man, aged thirty-one, with a right parietal lesion had complete left hemiplegia which cleared up largely, so that twenty-two

months after the wound a weakness of left arm and leg is alone recorded.

CASE VIII.—A man, aged twenty-four, with a right parietal lesion was partially paralyzed on the left side and lost complete control of the left hand: this had completely cleared up when examined five months after the wound.

CASE IX.—A man, aged twenty-nine, with a left parietal lesion had a foreign body removed in the C.C.S. and is recorded as having the entire left side paralyzed. He developed Jacksonian epilepsy while the hemiplegia largely cleared up. Such was his condition when he entered our clinic ten months after receiving wound.

CASE X.—A man, aged thirty-three, with a right parietal lesion was paralyzed in the left arm and leg for a month. There was still weakness in the arm and leg when examined four months after wound.

CASE XI.—A man, aged thirty-five, with left parietal lesion had hemiplegia and twenty-eight months after the wound he walks with a spastic gait.

CASE XII.—A man, aged twenty, with a left parieto-occipital lesion had weakness of the hand and leg for two months after the wound, when it cleared up.

CASE XIII.—A man, aged twenty-seven, with a right frontoparietal lesion had weakness of the left arm and leg when examined eighteen months after the wound.

CASE XIV.—A man, aged thirty-three, with a left parieto-occipital lesion of a most extensive character (gap 9 cm. by 12 cm.) had immediate right hemiplegia which gradually improved. When examined thirty-two months after the wound there remained only a weakness and slight numbness of the left foot.

CASE XV.—A man, aged thirty-five, with a right occipital lesion had a left hemiplegia which gradually improved. When examined thirty-two months after the wound there remained only a weakness and slight numbness of the left foot.

Lesions Producing Hemiplegia.—Parietal, 7; parieto-occipital, 3; fronto-parietal, 2; temporo-occipital, 1; occipital, 2; total, 15.

Results of Operation.—It is difficult to secure sufficient data in detail from the previous records of these men to make a comparative study as valuable as otherwise would have been the case. Nevertheless, some instructive observations were made, although in the most general terms, and with a most meagre history of the progress of certain of these cases.

It would appear that the hemiplegia was more or less complete in many instances and developed either immediately on receipt of the wound or, what was more commonly the case, within the first few hours afterwards. In every instance the condition showed progressive improvement, usually leaving a residual weakness, but in exceptional cases clearing up entirely.

It cannot be said that the closure of the defect had any remedial effect upon paralysis in these cases. In one instance hemiplegia developed after a cartilage graft had been inserted, along with Jacksonian seizures. The paralysis entirely cleared up and the fits ceased to recur after removal of

the graft, free dissection of scar tissue and the insertion of a fascial graft.

Jacksonian Epilepsy.—There were seven cases in whom epilepsy developed. Six of these were of the Jacksonian type.

CASE I.—A man, aged twenty-four, with a double lesion, one in the right frontal region and one in the occipitoparietal region. He was admitted to the clinic six months after the wound and had two fits in the ward before operation. The day after the operation for closure of a gap he had a fit, but they did not recur.

CASE II.—A man, aged twenty-six, with a left frontoparietal lesion had a fit immediately after being wounded. On admission fifteen months after the wound he was having frequent fits, as many as three a day. After operation he had three fits during the first night. During the subsequent fifty-four days while in hospital he only had one fit. These, however, subsequently recurred and after a period of four months he was readmitted; the cartilage graft was removed and a fascial graft substituted after free dissection of scar tissue, including dura mater and cortex. At the time of his readmission he had right hemiplegia. After the last operation this completely cleared in ten days and no more fits developed up to time of discharge nineteen days subsequently.

CASE III.—A man, aged twenty-nine, with a left parietal lesion, wounded November, 1917. A F.B. was removed in the C.C.S.; paralysis of the entire left side followed. This cleared up and the first fit occurred three months afterwards. Fits recurred about once a month. There was an aura of choking and nausea. When the fit develops it begins on the right side, clonic in type, he becomes unconscious and cyanosed, sleeps for two hours and awakens with terrific headache. Cranioplasty September 25, 1918, and reported on return of Jacksonian epilepsy in five months (February, 1919).

CASE IV.—A man, aged twenty-six, with a left parietal lesion, wounded August 15, 1917, followed by right hemiplegia at the C.C.S. Bits of bone and brain matter were removed. Seventeen days afterwards part of a hernia cerebri were removed, and four days subsequently the entire hernia cerebri was removed. He had aphasia, blurred vision, dizziness and frontal headache. The fits were Jacksonian in type, beginning by clonic spasms of right foot. Cranioplasty September 23, 1918, (cartilage) was performed. The wound suppurated and the cartilage sloughed out. Transferred to C.M.C.H. November 27, 1918. One fit had developed the day after operation. He had respite from these seizures for a time, but they eventually recurred and he died in a convulsion four months after the operation.

CASE V.—A man, aged twenty-six, with left temporo-occipital lesion. He was trephined the day after being wounded. He was paralyzed in the right arm and right leg. There is no history of convulsions following, but he suffered from occasional attacks of unconsciousness when excited or fatigued—*petit mal*—a cranioplasty was done January 15, 1919; one attack occurred the day after the operation but none subsequently.

CASE VI.—A man, aged thirty-three, with a very extensive gap in parieto-occipital region. Right hemiplegia followed the wound and subsequently he developed fits which recurred at the rate of about one every three months. A bone graft from the cadaver was introduced twenty-nine months after the wound. He had a fit three days afterwards and a second seizure three and a half months subsequently.

CASE VII.—A man, aged twenty-seven, with a right frontoparietal lesion was paralyzed in the left side. This largely cleared and he had a bone graft inserted, about a year after receiving wound, in Washington. Subsequently he developed Jacksonian epilepsy, with recurrence of the paralysis, and two years after the wound the bone graft was removed, a free dissection of scar tissue made, and a fascial graft substituted. He made an excellent recovery: the paralysis entirely disappeared and thus far (four months after operation) the fits have not recurred.

Lesions Associated with the Development of Epilepsy.—Frontoparietal, 2; frontal and occipitoparietal, 1; parietal, 2; parieto-occipital, 1; temporo-occipital, 1; total, 7.

Results of Operation.—It is worthy of note that of the cases in whom Jacksonian epilepsy developed all had a history of hemiplegia with one exception, and in all the gap existed in the parietal region of the cranium.

It is hazardous to draw any conclusions as to the effect of closure of a cranial gap upon the course of epilepsy. Undoubtedly relief is in many instances attained, but one cannot say that a permanent cure is effected. In civil practice one has seen acute epilepsy of the Jacksonian type clear up entirely after operation for cerebral abscess, and the patient continue free from seizures for years (in one case followed for nine years) with apparently a permanent cure. On the other hand, in my records I have the history of a man who developed his first attack twenty years after a brain injury. It is, therefore, impossible to say that we have effected a cure when, after a cranioplasty, our patients, as in some instances, have remained free from attacks for a few months.

Loss of Sense of Smell.—A man, aged twenty-four, had a double frontal lesion. The bullet entered just above the supra-orbital ridge on one side and made its exit above the supra-orbital ridge on the opposite side. There were two gaps with a bridge of bone between. This man had complete loss of smell, due, no doubt, to injury of the olfactory lobe of the brain.

Result of Operation.—The operation had no appreciable effect in restoring function.

Dyspnœa.—One case is recorded as having difficulty in breathing: this was a man, aged twenty-six, with a left frontoparietal lesion who had left hemiplegia and early developed Jacksonian epilepsy. The fits continued and were a feature of his case fifteen months after reception of the wound.

Sense of Fear: Nervous and Afraid of Being Struck on Head: a Feeling of Insecurity.—Such sensations were very common in men who had a gap in the cranium. Illustrated by the following:

CASE I.—A man, aged twenty-six, with a gap (3 cm. by 2 cm.) felt nervous and afraid. These sensations disappeared after cranioplasty.

CASE II.—A man, aged twenty-one, with a left posterior parietal lesion had constant fear of being struck on the head. This was relieved by cranioplasty.

CASE III.—A man, aged twenty-two, with a right frontal lesion was unable to stand any noise without getting extremely nervous.

Result of Operation.—Closure of the gap in such cases is most effective in allaying such distressing symptoms.

Marked Mental Depression.—This was recorded in certain instances. A man, aged twenty-three, with frontal lesion and gap (5 cm. by 3 cm.) who was a great sufferer from headaches and dizziness showed marked mental depression.

Result of Operation.—The result of operation is most beneficial.

Features of the Gap: Size, Pulsation, Impulse on Coughing, Depression Below Surrounding Surface.—The size varied from a small opening 3 cm. in diameter to a very large hole, which in one case measured 12 cm. long and 9 cm. wide. Most of the cases showed pulsation, but where the gap was small and the scar tissue over it firm, pulsation was absent. In nearly all cases there was an impulse on coughing. A very characteristic feature of these cases which was observed in practically all instances was that the soft tissues covering the hole would bulge when the man stooped over with his head between his knees: on assuming the erect attitude the bulging would be replaced by a marked depression. Lying on the operating table with the head slightly elevated and while under the anæsthetic there would be a slight depression as a rule. In one instance there was a marked depression at operation. This was due to the very large size of the gap and to the loss of substance in the meninges and in the brain itself.

Results of Operation.—These unfortunate patients all experienced the greatest possible relief as the result of firm closure of the gap.

The Scar.—The character of the scar tissue varied within wide limits. It became most important to study the degree of scar development and its relation to the gap. One feature common to all was the dense adhesion of the scar to the dura mater, necessitating the most careful dissection of the one from the other. An attempt was made to remove the scar tissue as completely as possible. If this were not done, it would probably slough subsequently, as its vascularity is so poor. Removal of the scar tissue is considered by us a most important feature of our technic.

Nausea and Vomiting.—It is a fact worth recording that in not a single instance was vomiting recorded as a symptom. This symptom is common in pathological lesions within the cranium, such as tumors, inflammatory conditions, etc., where increased pressure effects are a feature of the case. It is, therefore, perhaps not surprising that in the cases under consideration, where the intracranial pressure is, if anything, diminished, vomiting does not occur.

In one case there was nausea, this was present in a man aged thirty-two, who was knocked over by a shell exploding near him, sustaining a fracture of the skull in the left parietal region as the result of his fall. Four months after the injury nausea is noted as a feature of his case with headache and dizziness. Cranioplasty was performed, and all his symptoms were relieved.

Restricted Movement of the Lower Jaw.—A man, aged twenty-eight, with a right frontoparietal lesion situated immediately above the zygoma, the scar tissue was firmly incorporated with the temporal muscle, resulting in a fixation of the jaw so that the movement at the temporo-maxillary joint was restricted and he was unable to open his mouth except to a very limited extent. The muscle was freed at an operation performed in our clinic two years after receiving the wound, as a result the jaw movement was increased by 10 per cent.

Result of Operation.—The result of operation here, by the removal of scar tissue, was effective in restoring function to a considerable degree.

Type of Graft.—The type of graft was as follows: Cartilage, 27 cases; bone, 13 cases; fascia, 2 cases; total, 42 cases.

The cartilage grafts were all autogenous: the cartilage was removed from the lower costal cartilages of the patient.

The bone grafts were also autogenous with one exception, and were removed from the tibia of the patient. The exception was that of a large cranial defect which was closed by a piece of parietal bone removed from the human cadaver.

The fascia used was the fascia lata from the thigh of the patient.

There were three cases in which a silver plate had been inserted in England to close the gap. In each instance the plate had to be removed. These were as follows:

Case I.—A man, aged twenty-two, wounded in November, 1917, in frontoparietal region had a silver plate inserted to close the gap. The wound became infected and the plate was removed six months after its insertion. After another lapse of six months, the wound being soundly healed, the writer made a successful cartilage graft relieving the man of his headache and dizziness.

Case II.—A man, aged thirty, wounded in November, 1914, in the occipital region had a silver plate inserted in England four months later. The history states that following a fit of unconsciousness he had the plate removed in June, 1915. There was evidently some infection as a sinus persisted when admitted to our clinic. In spite of this, however, Major Wilson succeeded in doing a successful cartilage graft in January, 1919.

Case III.—A man, aged twenty-two, was wounded in October, 1917, in the frontal region. A month afterwards he had a silver plate inserted. The wound became infected and the plate was removed six months later. The wound then healed. In October, 1918, Captain

Shenstone performed a successful cartilage graft followed by complete relief of his headache and dizziness.

In one instance a bone graft which had been inserted in Washington was removed in our clinic.

The case is as follows:

A man, aged twenty-seven, was wounded in 1917 and had two operations in France at both of which fragments of bone were removed. Later a bone graft was done in Washington. He came to us because of having developed severe convulsive seizures and an incomplete hemiplegia with weakness of the leg and arm. In January, 1919, Major Wilson removed the bone graft, and made a free dissection of the scar tissue along with a considerable piece of dura mater. He replaced this by a fascial graft and its adherent fat. The fat was turned towards the brain cortex. The wound healed and the paralysis completely disappeared; thus far the convulsions have not recurred.

The Technic of the Operation.—The method of operating in this clinic has recently been described by one of our staff, Major Wilson, in the ANNALS OF SURGERY for March, 1919. The principles involved and the objects aimed at may be summarized as follows:

In exposing the gap in the cranium, the flap of scalp which is turned down must be freed as far as possible from all scar tissue. This is essential for two reasons, first to get rid of all tissue which may harbor infection and secondly to provide a covering for our graft which has a good blood supply. The flap does not include the pericranium which is left for the moment undisturbed. The area of skull uncovered must leave a margin of at least 3 cm. surrounding the gap. The reflection of the flap is not easy immediately over the gap, because at this point one usually encounters scar tissue, and it is firmly adherent to the dura mater, which is also scarred. In dissecting the flap free from the dura the latter is often opened at points from which cerebrospinal fluid escapes. Occasionally a fine catgut stitch is necessary to close these small wounds of the dura. In some instances it has been necessary to sacrifice a considerable piece of the dura mater. Under such circumstances we have found it quite satisfactory to transfer a piece of fascia lata from the thigh. The patch of fascia is placed with its fatty side towards the brain cortex, and with its margins underlying the edges of the dural gap. It is then secured in place by a few fine catgut sutures. The pericranium is now cut by a vertical incision which encircles the gap in the bone. This cut is made .5 cm. from the bony margin of the gap. The ribbon of pericranium thus mapped out is raised from the bone by an elevator and turned in upon the dura mater. One continues the separation in the same plane and separates the dura from the under aspect of the bone. By this means the bony margin of the gap is entirely bared on both surfaces. If any rough irregularities of bone project from the margin these are removed by rongeur forceps. The pericranium surrounding the field of opera-

tion is also separated from the bone by an elevator to the depth of 1 cm. The object of this is to utilize the cut margin of the pericranium for the purpose of securing the graft, when in place, by suture. By means of a burr or gouge the bony margin is now bevelled off, removing the outer table and leaving the inner table to act as a shelf to receive and support the graft. The bed is now prepared for the reception of the graft. Throughout the operation most careful attention is paid to hæmostasis. If it is proposed to make a cartilage graft, then a vertical incision six inches long is made two inches to the right of the middle line over the lower costal margin. The incision is carried down through the rectus muscle, which is retracted, and the cartilages bared. One then removes two-thirds of the outer surface of the cartilage, shaping a graft of sufficient size to fit the gap in the cranium. The piece of cartilage is subsequently fashioned to the exact shape and size necessary by cutting it with a sharp knife upon a wooden block. It is now placed in position, the edges of the graft resting firmly upon the ledge of the inner table, which has been prepared for its reception. Fine catgut sutures are now passed through the cartilage and the loose margin of pericranium which immediately surrounds it. The flap of scalp is then replaced over the graft and accurately secured by the silkworm-gut suture. A small drain being inserted at a suitable point to prevent the formation of a hæmatoma. This drain is retained in position for twenty-four hours.

The Cartilage Graft.—In placing the cartilage graft one or two additional precautions are necessary. The cartilage must be laid with the perichondrium towards the dura. In fact, it will be found difficult to place it otherwise, as it naturally curls somewhat to form a slightly concave surface on the side of the perichondrium, thus fitting more readily the contour of the skull. We have learned by experience that it is absolutely necessary to make the graft completely bridge the gap and lie supported upon the ledge of inner table prepared for its reception. If, for example, two pieces of cartilage are used to span the gap and their ends meet and lie free in the centre of the gap, the result is a failure to secure firmness, a certain amount of yielding will occur in such a graft which will permit of impulse on coughing and possibly pulsation. On the other hand, if the gap is unusually large, it may be necessary to use several pieces of cartilage to fill it. A good firm result may be obtained under such circumstances, provided each piece of cartilage completely spans the gap and rests securely at either end upon the ledge of inner table.

The Bone Graft.—The bone graft in all our cases, with one exception, has been cut from the tibia by means of a saw. Before doing this, however, the periosteum is cut through over an area of somewhat larger pattern and turned in over the graft while the saw cut is being made. The graft is now raised from the tibia by means of a chisel. The graft is placed in position in the cranial gap and is fitted in similar fashion to that described for the

cartilage graft. The redundant periosteum is now sutured to the surrounding pericranium and the graft is thus securely retained in place. In some instances we have drilled the graft and similarly drilled holes in the ledge of inner table and secured the graft by passing catgut through these holes, but this is not necessary.

The Bone Button Graft.—One of our staff, Major Gaby, has devised a method of making bone grafts, which, in suitable cases, answers admirably. The gap in the cranium is exposed in the manner already described. A trephine is then applied over the gap and the outer table cut through. The outer table within the circle of the trephine cut is then chiselled off and the inner table left as the shelf for the reception of the graft. The same trephine is now used to cut a graft from the tibia, cutting the periosteum over an area embraced by a larger circle and turning it in over the graft before the trephine is applied. A button of bone of suitable size is now isolated by the trephine and separated from the bone by means of a fine chisel. This is now placed in position in the cranial gap and secured there by stitching the periosteum to the pericranium with catgut. The method answers admirably, provided the gap to be closed is more or less circular in shape and not too large. Major Gaby has succeeded in closing the gap requiring a trephine two inches in diameter, by this means utilizing the entire width of the inner surface of the tibia. The tibial surface is not quite wide enough for the two-inch trephine, but the small part of the graft at opposite sides which fails to reach the supporting ledge in the cranial gap does not materially interfere with the firmness of the result. In small gaps the button fits accurately and is supported around its entire circumference.

The same principle may be applied in certain cases where the long diameter of the defect is too great for the use of a trephine. A rectangular ledge is cut by an Albee motor saw with a guide which prevents the saw cutting to a greater depth than the diploe. The outer table is then chiselled off, as in the trephine method. A tibial graft of accurate size is then cut with the motor saw, cutting to the same depth. The graft is then freed from the tibia by a very thin osteotome. This graft is then fitted in place in the same way as the bone button.

The Bone Graft from the Cadaver.—This means of closing a gap was utilized in one of our cases. It is one of unusual interest because of the very large size of the gap accompanied by a considerable loss of cranial contents. The method adopted will best be understood by detailing the case *in extenso*. It is as follows:

> A man, aged thirty-three, with a parieto-occipital lesion, the result of a wound received in September, 1916, was operated upon in our clinic twenty-nine months afterwards. He had hemiplegia after the wound and developed Jacksonian epilepsy. On admission he walked with a spastic gait, had flexure of the hand with plantar flexion of the

foot and right homonymous hemianopsia. His fits recurred at intervals of about three months. He had a very large cranial defect.

A piece of the parietal bone of a cadaver was prepared for the purpose of the graft. The exact measurements were 12 cm. by 9 cm. The intention was to close the gap in the cranium of our patient by placing the graft in the hiatus after preparing it in a special manner to ensure its vascularization and its firm consolidation with the tissues. The study of the fate of the graft in cases where it has been used in the plastic surgery of bone has led to considerable discussion as to the preservation of vitality in the case of the transference of the graft direct from living bone. Whatever interpretation may be placed upon the histological findings in experimental work there is no room for doubt as to the nature of these findings. Gallie and Robertson have shown that in the transplantation of grafts in the long bones of dogs there is a certain definite histological picture observed, while studying the changes which take place in the graft at various intervals until complete union of a fracture has occurred and firm consolidation of the graft with the living bone of the recipient dog has been secured. There is no difference in their findings between dead (boiled) bone and bone which has been immediately transferred from living bone for the purpose of the graft. The main features are vascularization of the graft by the ingrowth of new blood-vessels and the deposition of cells (osteoblasts) leading eventually to firm union. It would seem, therefore, that the graft should be prepared in such fashion as to favor this vascularization as much as possible. Hence it is found that cancellous bone is more suitable for the purpose than compact bone. The more porous the graft the more readily the blood-vessels grow into it. The sclerosed bone in the neighborhood of most ununited fractures is very unsuitable for such vascularization.

With these objects in view, it was determined to prepare the large graft of parietal bone so as to favor its vascularization as much as possible. The inner table of the piece of parietal bone removed from the cadaver was reamed off, leaving the rough cancellous surface of the diploë exposed. The bone was then penetrated by numerous holes through its entire thickness, these holes were 3 mm. in diameter and were placed with intervals of about 6 mm. over the entire graft, thus converting it into a sieve while still preserving a firm structure of sufficient stability for our purpose. The graft was then boiled and was preserved aseptic. At the operation the scalp of the patient was turned down in a flap, after a curved incision, so as to expose the hiatus in the skull, separating by dissection the scalp from the underlying adherent dura mater. This dissection was rendered difficult by the scar tissue present and some holes were made in the dura, allowing escape of cerebrospinal fluid during the process. Eventually the dissection was successfully accomplished and the margins of the hiatus were clearly defined. The pericranium was put 1 cm. from the edge of the hiatus and was detached from the bone and turned in upon the dura mater, the latter was separated for 1 cm. from the under aspect of the bone

edge all around the hiatus, so that one had the entire irregular edge of the bone surrounding the gap completely bare. The outer table of this bony ledge was reamed off: the margins of the graft had previously been bevelled in similar fashion, but on its inner surface; the graft was cut so that it fitted the hiatus accurately. The ledge formed of the inner table of the patient's skull was drilled with a number of holes and the graft was firmly secured in place by catgut passed through these holes and through the adjacent holes in the graft.

When we placed the graft in position over the hiatus it became evident that through loss of brain substance there was a considerable depression so that a considerable space existed between the graft and the dura mater underlying it. It was recognized that this would be a distinct menace, as it would certainly fill with blood or serum which would favor suppuration. We therefore filled in this cavity by removing a flap of fascia lata from the man's thigh. Fortunately he was fairly stout and we took a good thick pad of superficial fat along with the fascia lata. The plug of fat was turned towards the dura and the flap of fascia secured in place by a few catgut stitches, thus successfully filling the space beneath our bone graft. The scalp wound was then brought over the graft and secured by interrupted silkworm-gut sutures.

The man made an excellent recovery. It is now four months since the operation. He had a fit three days after the operation and a second seizure after the lapse of three months and a half. He is infinitely more comfortable than before the operation; he can now walk without assistance, a thing impossible for him hitherto. He has lost the headache which formerly distressed him: the mental depression from which he formerly suffered has entirely disappeared. The X-ray picture four months after the graft was inserted shows marked changes with gradual disappearance of the holes in certain portions of the graft, with apparently some condensation of the bone at these points.

The Fascial Graft.—The value of this form of graft is apparent in certain cases. In particular where there is much scar tissue and a graft of bone or cartilage is not successful. The operation consists in making a very free dissection of the scar tissue, including the implicated portion of the dura and cutting well down upon the cerebral cortex. This usually means, in such cases, the removal of a piece of dura almost as large as the cranial defect. A suitable piece of fascia lata is now obtained along with some of the overlying fat. The patch of fascia is somewhat larger than the defect in the dura. It is placed in position with the fatty surface towards the brain. The edges of the graft are made to underlie the edges of the dura and are secured there by fine catgut sutures. The scalp flap is then brought over the graft and sutured in position. Major Wilson of our clinic carried out this procedure in two cases with excellent results. In one case a man, aged twenty-six, had an aggravation of epileptiform seizures after a cartilage graft and became hemiplegic. The cartilage graft was removed after the

lapse of a month and the fascial graft substituted. The paralysis promptly cleared up and the fits ceased to recur. The case is too recent to conclude that he has permanent immunity from fits. The other case was a man, aged twenty-seven, wounded in 1917 in the frontopareital region. A bone graft was subsequently introduced, and after a lapse of some months he was admitted to our clinic suffering from severe convulsions requiring an anæsthetic to control them and with left hemiplegia. The bone graft was removed and a fascial graft introduced. The paralysis subsequently disappeared and he had no recurrence of fits when last heard from three months after operation.

Mortality.—There was no mortality in the series of 42 operations. Some of the patients in whom extensive operations were performed suffered severely from shock, but they all recovered. One of our patients (No. 4 in the series of cases of Jacksonian epilepsy) left the clinic, but subsequently continued to have convulsions of a most aggravated type. He eventually died in a convulsion four months after his operation. He had been subject to these seizures for six months prior to the performance of the cranioplasty, consequently his death could not be ascribed to the operation.

Infection.—It is remarkable that infection does not occur more frequently in view of the amount of scar tissue present and the fact that the vast majority of these patients must have had infected wounds primarily. In two of our cases a granular material, resembling bone dust, was found at the margins of the gap in the cranium. A culture of staphylococcus was obtained from both of these. In spite of that fact both wounds healed without suppuration and a firm successful closure was secured. It is obvious that the resistance of the tissues of the scalp and cranium to infection is much greater than the tissues about an infected bone in the extremities, where, notoriously, plastic work invariably fails in the presence of infection.

Infection of the wound followed in five of our cases only. In two of these cases (which were cartilage grafts) in spite of the infection, the wound healed and the graft remained firm. In three of the cases the graft was either removed or sloughed out. Two of these were cartilage and one was a bone graft.

Causes of Failure of the Graft.—I refer here merely to the failure to secure a firm closure of the gap by our operation. There were five of these. Three of them were the three cases of infection referred to in the preceding paragraph where the graft came away. The other two were among our first cases in which we failed to make the cartilage completely span the gap and lie as they should have done with each extremity supported on the ledge of inner table prepared for it. In one of these we removed the first graft and performed a second operation which was completely successful. The other showed some pulsation and impulse on coughing, but it was so slight we did not interfere. His symptoms were improved, but he still suffered from some slight headache.

The Fate of the Graft.—Our cases are all too recent to make any final statement regarding this most important phase of the subject under discussion. We have, however, made one or two observations of interest. Thus, in removing the cartilage in the case of insecure graft referred to above, one found it firmly united to the tissues in which it was imbedded, including the margins of the gap. Our pathologist, Capt. Laughlin, reports the histological findings as follows:

> The section embraces a portion of cartilage and subjacent fibrous tissue stroma. Fibrous tissue is firmly bound to cartilage over all its surface. In three or four places there are small collections of fibroblastic cells, lying in the cartilaginous stroma, which appear to be pushing inwards from the surrounding fibrous tissue. New blood-vessels accompany the growth or invasion of the cartilage. The cartilage consists of chondroblastic cells, in a more or less hyaline matrix, but scattered throughout are deeper staining areas. (Irregular deposits of calcareous material.) The cartilage is normal in appearance except for the fibrous tissue changes in the surface areas. The surrounding tissues are composed of a fibrous tissue stroma and new blood-vessels, with scattered areas of round-celled infiltration.

This piece of cartilage had remained *in situ* for eight months. The wound had healed without infection. We learned at least from this case that there had been no tendency to atrophy, and the cartilage had become firmly united to the margins of the gap. There is a suggestion that some calcareous deposit had occurred, but this, obviously, if it did occur, was extremely meagre and insignificant.

We have as yet little evidence regarding the fate of the bone graft. That changes occur in the bone is brought out in a striking manner in the X-ray picture taken of the very large graft, made from the cadaver (Figs. 2 and 3). The graft was 9 cm. by 12 cm., was composed of the outer table of the skull and was perforated by many holes 3 mm. in diameter. Under the X-ray the sieve-like appearance of the graft is evident. An X-ray plate taken three and a half months after the graft was inserted shows a gradual disappearance of the holes with apparently some condensation of the tissues in the places where the holes are disappearing. On feeling this man's head the graft is perfectly firm and solid as far as the graft is concerned. This fact, taken with the appearance in the X-ray plate, would lead one to hope that the changes which are obviously going on in the graft are such that it will remain and serve to close the hole permanently and successfully.

We have in no instance seen any tendency to absorption of the graft. Judging from experimental evidence and from our own experience we are hopeful that either bone or cartilage, if successfully implanted as a graft in a cranial defect and if the wound heals without sepsis, will unite with the tissues in which it is embedded and will persist as a permanent and satisfactory closure of the gap.

The Relief of Symptoms by Cranioplasty.—We have already studied the

FIG. 1.—Gap 9 cm. by 12 cm. closed by bone from a cadaver. X-ray before operation.

FIG. 2.—Gap 9 cm. by 12 cm. with bone from cadaver as a graft. X-ray seven days after operation.

FIG. 3.—Gap 9 cm. by 12 cm. with bone from cadaver as a graft. X-ray three and one-half months after operation.

relief of individual symptoms in our series. We may now make a general statement as follows: For our purpose we shall only consider the cases in which a completely satisfactory closure of the gap has been accomplished by a firm graft. There were 34 cases in which the operation *per se* was thus completely satisfactory. The bone graft under such circumstances and the cartilage graft seemed equally efficient.

Cases completely relieved of distressing symptoms.....	19
Cases rendered worse by the operation	2
Cases improved but not wholly relieved.....	8
Cases with no change in the symptoms	5
Total	34

CONCLUSIONS

It is possible to successfully close a gap in the skull by a graft of bone or cartilage, and thus restore the integrity of the unyielding cranial vault. The operation is attended by little danger to life as shown by the absence of mortality in our series of cases. The relief of symptoms directly dependent upon the existence of the gap is, as a rule, immediate and complete; such as headache, dizziness, the fear of injury and the sense of insecurity, occasionally the worry and mental depression dependent upon the possession of an ugly deformity particularly in the forehead. It is probable that when such a symptom as headache is not relieved, the trouble is dependent upon some condition additional to that of the cranial defect. The gratitude expressed by men who are relieved of these comparatively simple but most distressing maladies and who are rid of their deformity is sufficient guarantee that the operation is warranted.

The value of the operation in more complicated cases more particularly those suffering from Jacksonian epilepsy is less evident. Relief has been obtained in some of our cases, as we have noted above, but we can make no useful statement as to the probable permanence of that relief. On the principle that we should remove all sources of cortical irritation, if possible, in such patients, one might argue in favor of the operation, but the graft itself may be a source of irritation as evidenced in the case of one patient already referred to. In this instance a bone graft was removed and a fascial graft substituted with relief from the convulsions up to the present time four months after the operation. In the majority of our cases of Jacksonian epilepsy some measure of relief was undoubtedly secured. This would be explained by the relief of symptoms directly dependent upon the existence of the gap and the presence of scar tissue causing cortical irritation. We believe, therefore, the gap should be closed in these cases in order to eliminate the symptoms due to the existence of the defect and with the hope that in addition the epileptic seizures may be ameliorated.

The effect of operation on such symptoms as defective vision, aphasia,

loss of memory, deafness and other symptoms dependent upon organic cerebral lesions is of little or no value.

The value of the fascial graft is well worth considering. Where there is a cortical irritation, with much scar tissue implicating the dura mater, it is most serviceable to make a free dissection of the cicatricial tissue, removing the patch of dura mater involved and substituting a patch of fascia lata to close the rent. Our cases recorded above demonstrate its usefulness.

Finally, we may conclude by stating our belief that where a gap exists in the cranium it should be closed. The symptoms caused by the existence of the gap and directly dependent upon it will almost certainly be relieved by a successful cranioplasty.

FIG. 1.—Decompression combined with osteoplastic flap. This procedure interferes with the tourniquet.

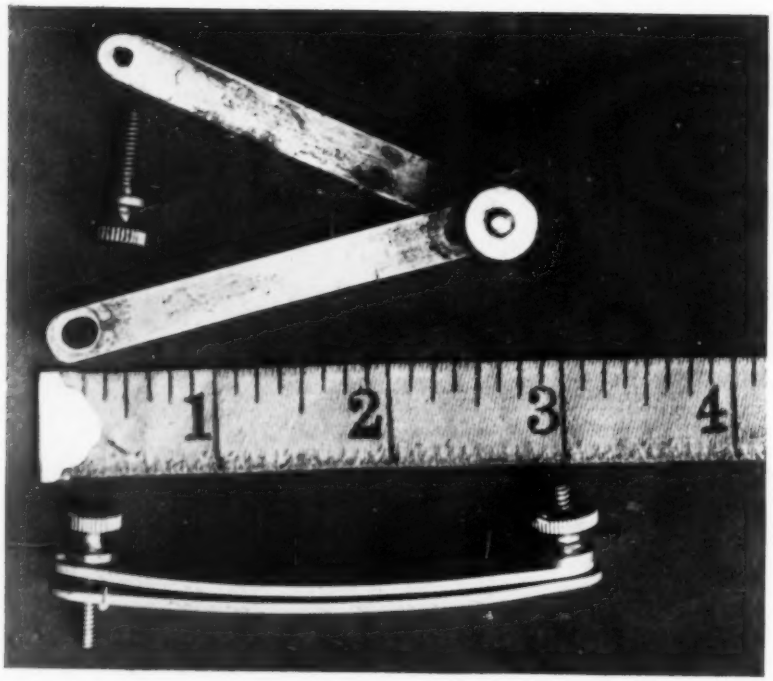

FIG. 2.—Shows clamp open and closed.

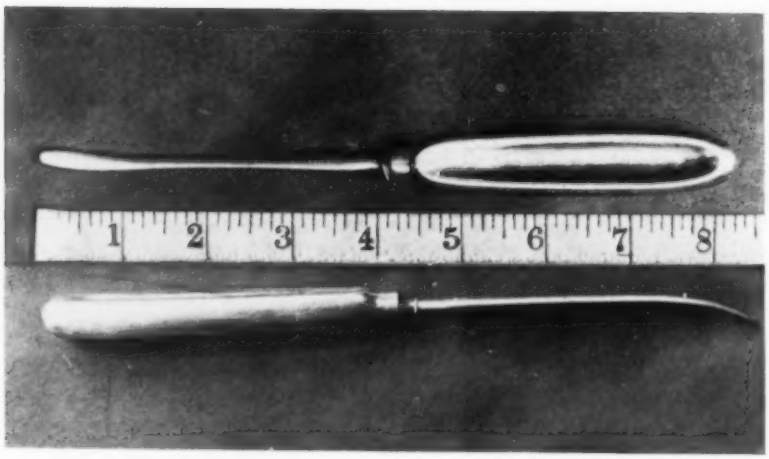

FIG. 3.—Staphylorrhaphy dissector.

FIG. 4.—Shows the clamp in place.

A CLAMP FOR OSTEOPLASTIC CRANIOTOMY

By Ernest Sachs, M.D.

of St. Louis, Mo.

Associate Professor of Surgery, Washington University School of Medicine

Fortunately, the cranial surgeon no longer is confronted by the problem of controlling hemorrhage from the scalp during extensive craniotomies. Until ten years ago this was an ever-present danger, to combat which specially constructed clamps and various methods of passing sutures were devised by Heidenhain and others. These were all discarded when the tourniquet was introduced for this purpose. The method of applying it was best described by Cushing in "Keen's Surgery," vol. iii, page 263.

I had been making use of this method until four or five years ago. At that time, however, I began to combine more and more frequently a decompression operation with my osteoplastic procedure as shown in Fig. 1. The removal of bone under the temporal muscle released the tension of the tourniquet and troublesome bleeding from both edges of the incision occurred. As I frequently am unable to tell beforehand when I may combine a decompression with my osteoplastic procedure, I discarded the tourniquet four or five years ago and simply clamped all my vessels as I made my incision. This has two objections, first, somewhat more time is consumed in the operative procedure, which is of comparatively little significance if thereby meticulous hæmostasis is obtained. Second, the large number of clamps on both sides of the incision get tangled up and the stripping of the soft tissue from the bone flap may more readily occur, an accident that I always dread, though it has thus far never happened to me.

For these reasons, therefore, I have been making use of the clamp illustrated in Fig. 2, which enables one to dispense entirely with all clamps on the flap side of the incision. It is applied as follows:

The incision is outlined on the skin in the usual way and the field then draped. Two small incisions, each not more than one-half inch in length, are made at the two ends of the incision. These are carried down to the bone. A staphylorrhaphy dissector, Fig. 3, is passed from one incision to the other, stripping the periosteum from the bone. One jaw of the clamp is slipped through this space, the other jaw is slipped into place, and the screws are tightened sufficiently to control all hemorrhage (Fig. 4). They should not be made too tight lest they strangulate the tissues. The clamps are made of varying lengths and shapes to fit different heads.

I have found this a helpful adjunct in my work and trust it may prove of value to others.

THE RESULTS OF SPLENECTOMY IN THE ANÆMIAS*

By William J. Mayo, M.D.

of Rochester, Minn.

Splenectomy as a curative agent has been given a fair trial in three types of the anæmias, and its successes and failures may be reasonably shown by the data at hand. It is my purpose to discuss the operation in cases of splenic anæmia, pernicious anæmia, and hæmolytic icterus from this standpoint.

SPLENIC ANÆMIA

While splenic anæmia is, as pointed out by Osler, a clinical entity, it cannot be said to have a definite pathologic existence. It may be defined as a splenomegalia with a secondary type of anæmia which is progressive but not constant until the later stages. This secondary anæmia has no special characteristics except that as a rule it is accompanied by a leucopænia, although we have seen otherwise typical cases in adults with leucocyte counts around from 10,000 to 12,000. Splenic anæmia was designated by many of the early observers splenic pseudoleucæmia, and it is believed by some clinicians of the present day that von Jaksch's disease (infantile pseudoleucæmia) is an infantile form of splenic anæmia in which a moderate leucocytosis due to the higher values of leucocytes in the normal blood of infants is to be found.

A number of pathologic conditions of the spleen which more or less resemble splenic anæmia have been classified as splenic anæmia, especially that of syphilitic splenomegalia. A few clinicians regard all splenic anæmias as syphilitic in origin, but this theory is not borne out by our experience. Chronic enlargements of the spleen that are accompanied by anæmia and are the result of various protozoa, syphilis, malaria, kala-azar, etc., as well as those anæmias due to bacteria, typhoid and tuberculosis, were removed from the splenic anæmia group when their etiology was discovered.

Hæmolytic icterus has often been confused with splenic anæmia. Occasionally pernicious anæmia, when accompanied by a large spleen, has been diagnosed splenic anæmia. Put in the form of an Hibernianism, incomplete knowledge is essential to the diagnosis. If we know the cause of splenic anæmia it is not splenic anæmia. It is a question, however, whether we have not been too insistent on the lack of knowledge as evidenced by unknown etiology as one of the chief features of splenic anæmia. I believe we would get a much better idea of splenic anæmia if we made the pathologic condition of the spleen and its effect on the blood the criteria, and classified as splenic anæmia all cases of known causation as well as those of unknown causation, assuming that in the course of

* Read before the American Surgical Association, June 18, 1919.

time we shall find the toxic agents which produce the condition of the spleen.

The pathologic characteristics of the spleen in splenic anæmia are generalized fibrosis with compression atrophy of the malpighian corpuscles, and endophlebitis. It may be said that enlarged spleens that show such characteristics will develop chronic anæmia without regard to causation. In five instances we removed large spleens in cases of chronic intractable syphilis with severe anæmia in which the patients had been carefully treated for syphilis for months. After the removal of the spleen, the anæmia rapidly disappeared and the syphilis was cured with comparatively mild antiluetic treatment, such as had previously failed to affect either the syphilitic condition or the spleen. In three of these cases gummas were found in the liver, in two, small gummas were found in the spleen, and in two the spirochæte was stained in the splenic tissues.

In 1883 Banti first described an enlargement of the spleen accompanied by atrophic cirrhosis of the liver of the Laennec type. The relation of splenic anæmia to Banti syndrome is most interesting. The majority of clinicians, I believe, agree with Moschcowitz in the conclusion that there is no real difference between the two and that Banti's disease is merely a late phase of some cases of splenic anæmia. It is certainly true that a considerable percentage of cases of splenic anæmia in the later stages will be found to be associated with portal cirrhosis of the liver, but not always of the atrophic type; the liver is as frequently enlarged as contracted. On the other hand, some observers believe that all cases of this description are primarily portal cirrhosis and that the splenomegalia is secondary. When the condition is seen in the later stages, it is difficult, if not impossible, to determine whether it was primarily portal cirrhosis with secondary splenic manifestations, or primarily splenic anæmia.

Gastro-intestinal hemorrhages, especially hæmatemesis, and ascites occur in splenic anæmia and in portal cirrhosis. After all, cirrhosis of the liver is essentially a fibrosis which exhibits more fixed characteristics than the spleen because the liver cells are all of one type and react uniformly to chronic irritation, while the spleen has differentiated groups of cells which permit of wide architectural changes. It is also to be noted that the blood comes directly in contact with the splenic pulp, as the vessels retain only their endothelial coverings; this may account for the endophlebitis, which is so marked a characteristic of splenic anæmia. Occasionally an enlarged spleen will be found, especially in women, without known cause and without anæmia. This condition may exist for years, but eventually anæmia results. In several cases of this type, when the patients finally came to operation, the spleen was fibrotic. It is probable that fibrosis of the spleen from any cause will eventually produce chronic anæmia and, other things being equal, such spleens should be removed when appropriate treatment fails to cure.

Of sixty-one patients with splenic anæmia from whom we removed the spleen seven (11.7 per cent.) died.[1] The deaths occurred in patients operated on in a late stage of the disease, in which there was a high grade of anæmia, ascites, and cardiorenal manifestations. In three patients acute thrombosis of the superior mesenteric and portal veins was the immediate cause of death; extensive thrombosis, evidently of long standing, was found in the splenic veins. These observations are in accord with those of Dock and Warthin, who found extensive thrombosis of the splenic vein in two patients who died from splenic anæmia and in which there was ascites without cirrhosis of the liver. It would appear that the spleen, acting as a filter, removes noxious agents, both microörganisms and chemical toxins, from the blood stream and sends them to the liver for destruction; in certain instances cirrhosis of the liver as well as fibrosis of the spleen results from the chronic irritation produced by such substances. If the spleen is unable to rid itself of all these toxic agents, splenomegalia and anæmia result with sequestration of the agents in the spleen, as in spirochætal and plasmodial infections, but the liver is not necessarily cirrhotic. Why the liver is cirrhotic in some cases and not in others is not known.

Both portal cirrhosis and splenic anæmia lead to death through portal obstructions, and the hemorrhages and ascites are due to back pressure. If the spleen is removed early in splenic anæmia, we know by experience that the liver will probably not show serious evidences of disease later, and even when cirrhosis of the liver is well marked and ascites is present, removal of the spleen often effects a "near" cure. The first thought is that by removing the spleen toxins filtered from the blood are prevented from passing to the liver. On further consideration it seems that the true explanation is this: Inasmuch as the normal spleen carries about 30 per cent. of the blood to the liver and that from these huge spleens the splenic vein may carry as much blood to the liver as the remaining elements of the portal vein, splenectomy relieves the liver of its overload and reduces its labor sufficiently to enable it to meet its demands, just as sometimes follows the Talma-Morison-Drummond operation. Fagge, many years ago, described a series of cases in which persons apparently in perfect health, coming to their death by accident, proved at necropsy to have advanced cirrhosis of the liver, but with so good a compensatory circulation along the vascular channels of Sappey as greatly to reduce the circulation in the liver and enable it to maintain its function.

Many patients splenectomized in the late stages of the disease with marked ascites and frequent hemorrhages from the stomach, etc., have been cured. Balfour, in a recent article on gastric hemorrhages of splenic origin, reports in detail a case in which the removal of a spleen a

[1] These statistics extend to December 31, 1918, and include as operative deaths all patients dying in the hospital without regard to cause of death or length of time after operation.

little larger than normal, checked gastric hemorrhages of many years duration, from which the patient was almost exsanguinated. The patient has remained well for nearly three years. We have since had a similar experience. A patient in extremis for whom repeated blood transfusions failed to afford even temporary relief was cured by splenectomy. Sherren and others have called attention to the fact that after the removal of the spleen for splenic anæmia an occasional patient has a recurrence of hemorrhages. We have had one case of this kind, but such experiences are unusual. I would call attention to the important fact that in five of these cases the diagnosis of splenic anæmia was not definitely established, but the five cases fitted into this group better than into any other. Future progress in knowledge of splenic conditions may change the interpretation of the facts and alter the diagnosis.

PERNICIOUS ANÆMIA

The etiology of pernicious anæmia is unknown, the early symptoms are indefinite, and by the time the diagnosis can be made the disease is incurable. The disease may be described as a progressive degeneration of the red blood in which there is a loss of the blast or mother cells of the erythrocytes; the blast cell when lost is not replaced. In contrast to splenic anæmia which is of the secondary type, the blood picture in pernicious anæmia has characteristic cells which mark the disease. The color index, or hæmoglobin percentage, is higher in proportion to the number of red cells present than in the secondary anæmias. The lemon color of the skin, sometimes with an icteroid hue, is so different from that in the secondary anæmia that sometimes a diagnosis is possible by looking at the patient. This icteroid hue is more prominent in cases in which hæmolysis is marked, as shown by examination of the duodenal content after the Schneider method. If we might assert that in cases of pernicious anæmia in which hæmolysis is most marked patients have a greatly enlarged spleen or that the spleen exhibits definite pathologic changes, we would have succeeded in establishing a direct connection between the enlarged spleen so often found and the disease. Unfortunately, our experience does not support this hypothesis, and the size of the spleen does not seem to bear a definite relationship to the severity of the disease. Necropsy, after death from pernicious anæmia, as a rule shows a small spleen, but in two only of our cases was the spleen below normal (195 grammes, Sappey) at operation, and both were terminal cases.

The average weight of the spleens removed in our cases of pernicious anæmia was 400 grammes, exclusive of two large spleens, one of which weighed 2220 grammes and the other 1600 grammes. It seems probable, therefore, that in pernicious anæmia the spleen is enlarged during the early and middle stages, and that the contraction so often found at necropsy is a terminal condition. The question is as yet unanswered whether per-

nicious anæmia is a definite and specific entity, or whether it is a terminal change of several conditions, and recognized only as pernicious anæmia when the patient has reached a stage which we know will eventually cause death.

Any form of treatment for pernicious anæmia may prove, or at least may appear to be, beneficial. Even without treatment these patients have their ups and downs, and it is not an infrequent clinical experience to have a patient present himself with symptoms which might be construed as being those of an early pernicious anæmia, and then with or without treatment recover and remain well. In eliciting the history the physician finds that the symptoms are often indefinite in the earlier stages, before the blood changes become characteristic.

Splenectomy in pernicious anæmia does not appear to be based on sound reasoning and there seems to be no foundation for the belief that the procedure will cure pernicious anæmia. Eppinger first suggested splenectomy as a cure for pernicious anæmia, and the early reports with the abundant testimony as to temporary relief were quite sufficient to give the operation a fair trial in this hopeless disease. Considering the confusion which so often attends the early diagnosis, it seems probable that obscure cases of hæmolytic icterus and splenic anæmia have been accidentally included in the pernicious anæmia group. Removal of the spleen in such cases has given the impression that splenectomy cures pernicious anæmia. At the same time in the investigation of our cases of splenectomy for pernicious anæmia, we see great, though temporary, improvement. There is a gain in weight, and an improvement in the blood from an average hæmoglobin of 38 to 72 per cent., and the reds from two to four millions. Splenectomy seems at least to have instituted a marked palliation.

In our experience in the cases in which the results were most favorable the symptoms were less characteristic of pernicious anæmia. In young and middle aged persons in whom the disease is most rapid, especially if hæmolysis is known to be marked, splenectomy is worthy of trial. Taken as a whole, it may be said that whenever pernicious anæmia has developed to the stage in which the blood is characteristic it is incurable, and splenectomy is a means of palliation and not of cure. Since there is an operative mortality good reasons must exist for substituting operation for repeated blood transfusions. We have splenectomized 50 patients with pernicious anæmia with three deaths (6 per cent.).

HÆMOLYTIC ICTERUS

Hæmolytic icterus has not been classified with the anæmias, but as pointed out by Kanavel and Elliot, the peculiar splenic activity results in an anæmia which is the cause of death. As in splenic and pernicious anæmias, the etiology of hæmolytic icterus is unknown. The well devel-

oped hæmolytic icterus stands out with a vividness, unequalled in splenic anæmia and in pernicious anæmia. These three diseases, all of unknown etiology and lacking sound pathologic foundation, when examined in the minutiæ are without distinctive features. Viewed in the perspective they are outstanding clinical entities. The characteristic features of hæmolytic icterus are an enlarged spleen, chronic jaundice with exacerbations, normally bile colored fæces, and absence of bile in the urine.

It is certain that in hæmolytic icterus the spleen destroys, unnecessarily, the red corpuscles; the enlargement of the spleen may be in the nature of a work hypertrophy. Enlargement of the liver is usually present and may also be a work hypertrophy. In some of our cases sections from the liver showed definite hyperplasia of liver cells.

There are two types of hæmolytic icterus, the familial or congenital type of Minkowski, and the acquired type of Hayem and Widal. In the familial type the disease may be noticed from infancy and it may not be progressive; the patients live the allotted span of years in a fair degree of health, but with more or less jaundice throughout life. These cases are not uncommon and are to be seen in every community; a large percentage develop a more serious condition which makes them indistinguishable from the acquired type, and like the acquired type, the disease progresses in the course of some years to a fatal ending.

Chauffard and Widal have pointed out that the red cells are less resistant in hæmolytic icterus than normally, and our experience confirms these observations. Sanford has worked out a simple and very reliable method of examination for red cell fragility which we have used in the clinic extensively and with great satisfaction.

THE RELATION OF HÆMOLYTIC ICTERUS TO THE LIVER AND ITS CIRRHOSES

We find in hæmolytic icterus an occasional case in which biliary cirrhosis is associated. Brushing aside the familiar classification of the cirrhoses of the liver in which variations in the morphology lead to unnecessary confusion, there are but two fundamental hepatic cirrhoses: (1) The portal, in which the toxic material reaches the liver by way of the portal vein, and in which the connective tissue is deposited about its radicals and death is caused by portal circulatory obstructions, ascites, gastro-intestinal hemorrhages without jaundice until shortly before death, etc., and (2) biliary cirrhosis, caused by an infection of the biliary ducts in which the connective tissue is deposited about the biliary ducts causing jaundice but without ascites or hemorrhages until shortly before death. More often this is an ascending infection from associated gallstone disease, especially gall stones in the common duct; at times it is hæmatogenous from focal infections in any part of the body; the pancreas is frequently associated in a chronic pancreatitis. Just as we have many varieties and subvarieties of portal cirrhosis, so we have many varieties

and subvarieties of biliary cirrhosis, but we should not be led astray by the many patterns which may appear any more than we should name wall-papers or carpets differently according to their patterns. Normally blood pigments are the source of the coloring matter in the bile. In hæmolytic icterus the enormous destruction of red corpuscles in the spleen inundates the liver with blood pigments, and renders the bile thick. One can conceive that, under such circumstances, a liver which has a superabundance of work of a certain kind thrown upon it may deposit pigments throughout its tissue, thus producing many of the patterns which are given as varieties of biliary cirrhosis. As there is no infection there is no cirrhosis, but there is, as I have stated, some enlargement of the liver.

The viscid bile in hæmolytic icterus tends to form gall stones. Sixty per cent. of all the patients with hæmolytic icterus on whom we operated had associated gall stones and all the possibilities of biliary duct infection. It may readily be understood why biliary cirrhosis is sometimes associated with hæmolytic icterus and why the two diseases have been confused. It should not be forgotten that in portal cirrhosis and in biliary cirrhosis the entire liver may not be involved in the cirrhosis. We frequently see limited areas of cirrhosis without attending symptoms because the organ is not extensively involved. Hæmolytic icterus has been most often confused with the elusive syndrome termed Hanot's cirrhosis, which, so far as I know, has no pathologic foundation, and if it occurs clinically I have never seen it.

The triumph of splenectomy is the cure of hæmolytic icterus. We have had no more satisfactory results in surgery than are to be found in this group of cases. Only patients in a terminal condition with secondary gall stones and cirrhosis of the liver fail to be relieved. The only patient we lost of the twenty-seven splenectomized for hæmolytic icterus was one operated on during an acute exacerbation. Crises are a part of the picture of the disease, and when severe have usually been due to gall stones, although it is undoubtedly true that exacerbations do take place from unknown causes in which there is great but temporary increase of jaundice, with tenderness and increased tumefaction of the spleen and usually of the liver, without gall stones. On gross section the spleen in hæmolytic icterus is dark, mottled, filled with blood pigments, and quite distinct from the spleens which we have removed for other conditions.

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THE TREATMENT OF GUNSHOT WOUNDS OF THE CHEST *

By Ellsworth Eliot, Jr., M.D.

of New York

The symptoms of gunshot wounds of the lung, in those who survive the initial hemorrhage, need no special description. Here, as in other parts of the body, the development of subsequent infection depends largely upon the nature of the wound. In civil surgery, perforating wounds in which the missile escapes, and penetrating wounds in which the missile lodges in the lung, frequently heal without incident. In war surgery an equally satisfactory course may be expected in corresponding wounds the result of machine-gun bullets. On the other hand, fragments of high explosive shells, the cause of many pulmonary wounds, are frequent carriers of infectious material which may or may not be removed in the act of penetration by contact with the soft tissues of the chest wall. In all varieties of gunshot wounds of the chest, whatever the type, but more especially in those due to a high explosive agent, an associated hæmothorax materially increases the likelihood of infection, for the resistance of the patient is diminished by the actual loss of blood, usually amounting to between one and two litres, and by the respiratory and circulatory embarrassment which result from the pressure of the pleural contents on the lung and heart, while the clotted blood itself provides a favorable culture medium for whatever pathogenic organisms may have been introduced.

All of the cases reported in this paper were complicated by a hæmothorax which required either aspiration or thoracotomy, and the selection of these cases was made because of the belief that, of all chest wounds, in this particular group, if in any, radical rather than conservative treatment would seem to have been justified. They would appear, therefore, to serve most appropriately as a basis for the discussion of the relative value of these two methods of treatment.

For the purpose of such consideration, these wounds may conveniently be divided into perforating and penetrating. In the former group, an expectant plan of treatment has proved, in the opinion of all surgeons, more desirable than radical measures. Four cases of this character, herewith reported, required aspiration of the associated hæmothorax. This was done forty-eight (two cases) and seventy-two (two cases) hours, respectively, after the receipt of the injury. The amount of blood removed varied from an ounce and a half to one and one-half quarts. The relief of subjective and objective symptoms, indicative of circulatory and respiratory embarrassment, was generally immediate and satisfactory. In

* Read before the American Surgical Association, June 16, 1919.

Case IV, the relief of dyspnœa and pain through the withdrawal of only one ounce of blood would point to pleuritic reflex irritation rather than to pressure as a probable etiological factor of the symptoms mentioned. All four cases recovered and were evacuated in seven days after all respiratory embarrassment had disappeared.

Penetrating wounds include those with the lodgment of a foreign body in the pleural cavity and those complicated by the retention of fragments in the lung itself. Of the former there were several instances which are not included in this report, as in none was aspiration necessary. If the projectile is impacted in the pleural opening and can be reached in the course of the débridement of the external wound, its removal is preferable. Care must be taken, however, during the necessary dissection to prevent the accidental detachment and subsequent escape of the foreign body to an inaccessible part of the pleural cavity either by firmly grasping it with a tenaculum or by passing a needle beneath it, for it is quite like the joint mouse in its lack of toleration of restraint.

The removal of foreign bodies that have already reached a portion of the pleural cavity remote from the wound of entrance, should be attempted only in case they cause undue irritation or lead to infection. Their successful removal usually requires extensive exposure, a procedure which, in view of the proximity of the usually infected wound of the chest wall, may readily lead to infection of the entire pleural cavity. In this group of cases, as well as in the much more common group in which it has lodged in the lung, the surface of the fragment seems at times to have been cleansed of infectious and foreign material by contact with the divided soft parts of the chest wall, for while the extra-thoracic path of the projectile frequently becomes infected, the portion lying within the pleural cavity or the lung generally escapes.

The second and by far the most frequent group of penetrating wounds of the chest includes those in which the projectile has lodged in the lung tissue. The question of its immediate removal from this location or of leaving it undisturbed has been a subject of frequent debate.

Of the 15 cases of this character, herewith reported, in which the associated hæmothorax required aspiration, 13 recovered and 2 died. Of the latter one had already developed a serious pleuritic infection prior to admission to the hospital, while the other was complicated by a pericarditis. In neither did the condition of the patient warrant intervention. Those who recovered were evacuated after the complete subsidence of all pulmonary symptoms, usually at about the tenth day, and in none before the expiration of a week. Apart from the relief of the associated hæmothorax, which, in two instances, required a thoracotomy under local anæsthesia on the fifth and sixth days, respectively, the treatment was conservative and the patients were evacuated with the projectile still *in situ*. The thoracotomy was done only after two attempts to aspirate had failed. In all of these cases, as in the four instances of perforating

wounds, aspiration promptly relieved both the pain and dyspnœa. No infection developed, although aspiration, and especially thoracotomy, done under conditions of war surgery, might easily lead to that complication.

Aspiration was usually done on the second or third day when it was evident that the circulatory and respiratory disturbances were not subsiding, and an average of from one to one and a half litres of bloody serum was removed. In one instance, after the removal of one and one-half litres of blood at the end of forty-eight hours, two additional litres of blood-stained fluid were removed five days later. In the interval there had been no indication of hemorrhage, and the character of the aspirated contents pointed to the original bleeding as the probable source of the "recurrence." In no instance was aspiration followed by a renewal of the hemorrhage, a fact that appears to controvert the theory that the removal of a large quantity of pleural contents predisposes to subsequent bleeding. To remove only a small portion of the extravasated blood in hæmothorax at any one time is therefore unnecessary as well as undesirable, for repeated aspirations at frequent intervals are doubtless harmful to patients in a depleted condition who are fighting for breath and suffering from a lack of adequate circulation.

Apart from aspiration, the question of the immediate removal of the fragment from the pulmonary tissue has been, as already mentioned, the subject of considerable debate. Its immediate removal is unquestionably associated with a much higher mortality than allowing it to remain undisturbed, which may well be ascribed to a condition of lowered vitality and therefore of diminished resistance, due to one or more of the following factors: To exposure before and after the receipt of the injury; to insufficient nourishment; to the associated hemorrhage, either externally or into the pleural cavity; to the transportation to the hospital, which is rarely reached before the expiration of from six to twenty-four hours. Furthermore, the risk of an attempt to remove the foreign body is increased still more by the formidable character of the operation, which, together with the added inevitable loss of blood, is, in view of the general condition of the patient, sufficient to determine a fatal issue. Finally, the exposure of the lung, essential to the removal of a foreign body therein located, establishes a large communication with the already infected portion of the wound in the chest wall and thereby predisposes to the extension of the infection into the pleural cavity.

On the other hand, by conservative treatment, opportunity is afforded for almost complete restoration of vitality, and if the development of infection or, later on, the continued irritation of the foreign body justifies operation, it may be done under much more favorable conditions and with much greater chance of success. Although as yet the writer has seen no publication of pathological conditions arising from infection proceeding from the retention of high explosive fragments in the lung, it is reasonable to infer that the resulting abscess would be circumscribed

and that its contents would either spontaneously discharge into a bronchus or else, approaching the chest wall, would result in a localized empyema, in which event the opening of the abscess and the removal of any foreign material which it might contain could be easily and safely accomplished. As a matter of fact, several cases which followed this favorable course were observed by the writer in base hospitals around Tours.

The cases herewith reported, although small in number, indicate that immediate infection is uncommon. In one instance infection had already developed prior to the admission of the patient, and was unquestionably chiefly responsible for his death. Unfortunately none of the other patients who recovered were evacuated to any of the hospitals to which the writer was subsequently assigned as consultant, and therefore the final results cannot at present be determined. The writer has learned in a general way from those colleagues in whose care some of these patients were placed, that their further course was quite satisfactory and that the removal of the retained foreign bodies did not prove necessary. This fact strengthens the contention that pleuritic or pulmonary infection is unlikely to develop in patients who remain free from such infection for a period of ten days after the receipt of the injury. Whether infection will subsequently occur in the pulmonary tissue adjacent to and inclosing the projectile can only remain a matter for conjecture. The susceptibility of the lung to infection, as compared with other organs, presents a most interesting topic for investigation. Yielding easily, for example, to the tubercle bacillus, is it more or less resistant to other organisms, especially to those of a pyogenic character? Whatever the actual explanation, it seems reasonable to infer that, as a general rule, fragments of high explosive shells, many of which originally carried agents of infection, will remain in the lung quiescent, indefinitely.

Of the open sucking wounds of the pleura no mention has been made. The desirability of their closure at the earliest opportunity is undisputed. This closure to avoid tension should be made when necessary by the insertion into the opening of a musculo-aponeurotic flap in order that the reopening of the pleural cavity may be avoided, a condition which seriously threatens the life of the patient.

In conclusion attention is directed to the serious character of infection attacking an entire pleural cavity and its lack of resistance in comparison with the peritoneum. One instance of this kind has already been mentioned in which, after forty-eight hours, the death of the patient occurred, and several other instances of similar infection, due to the penetration of foreign bodies, have been observed by the writer in civil practice. This condition is best treated by prompt and relatively protracted drainage at the most dependent angle of the pleural cavity, a counter-opening being made for that purpose whenever necessary.

The writer wishes to acknowledge his indebtedness to Captain Harold

F. Budington, of Springfield, Mass., for his kindness in the preparation of the abstracts of the histories of these cases and for his conscientious care of the patients themselves.

PERFORATING WOUNDS OF THE CHEST

CASE I.—Machine-gun bullet from outer end of right clavicle to lower end of right scapula. Aspiration forty-eight hours later withdrawing half a pint of serous fluid, followed by immediate relief of sense of weight and pressure over chest with improvement in breath-only slight cough and no dyspnœa except on exertion.

CASE II.—Machine-gun bullet from third rib anteriorly to ninth rib posteriorly on right side at a point two inches below angle of scapula. Aspiration of 6 ounces of bloody fluid forty-eight hours later on account of dyspnœa cough with bloody expectoration. Immediate relief of these symptoms followed. Evacuated in good condition at the end of a week.

CASE III.—Shrapnel wound entering upper right chest below outer end of clavicle, the wound of exit being in the back on the same side. Dyspnœa and rusty sputum. Aspiration at the end of seventy-two hours withdrawing one and one-half quarts of bloody fluid with marked relief of the dyspnœa. Evacuated later in excellent condition.

CASE IV.—Shrapnel wound below middle third of right clavicle, foreign body being located a short distance beneath the skin near the inferior angle of the scapula, from which point it was removed by a counter-incision; seventy-two hours after receipt of injury one ounce of clotted blood removed by aspiration, followed, notwithstanding the small amount, by relief of both the dyspnœa and pain. Evacuated in excellent condition one week later.

PENETRATING WOUNDS OF THE CHEST

CASE V.—Shrapnel wound just below left clavicle near the shoulder, X-ray disclosing the shadow of a foreign body moving with respiration. Patient was suffering from marked shock and dyspnœa. Forty-eight hours after injury, one quart of bloody fluid removed by aspiration from the left pleura followed by considerable improvement in cyanosis and respiration. These symptoms, however, together with the physical signs of fluid still persisted, the bloody expectoration becoming mucopurulent. On account of the persistence of dyspnœa a second aspiration was done seven days after the receipt of the injury, removing two quarts of dark bloody serum. For two days prior to the second aspiration the patient's temperature was between 104° and 105°, thereafter gradually diminishing to normal. Patient evacuated on fourteenth day, in good condition with ing. Evacuated at end of week in excellent condition.

CASE VI.—Shrapnel wound with point of entrance in left anterior axillary line two inches below the nipple, X-ray showing a small

foreign body near the left nipple moving with respiration. There was severe coughing and dyspnœa, due at least in part to mustard gas burn of face and respiratory tract. Twenty-four hours after receipt of injury withdrawal of clotted blood by aspiration. Four days after receipt of injury aspiration was repeated. As only a small amount of clotted blood was removed and both pain and a dyspnœa continued, a thoracotomy was done by Doctor Budington under cocaine on the following day, removing a considerable amount of clotted blood and slightly blood-tinged serum, drainage being provided for a time with a rubber tube. Improvement of all symptoms with evacuation in ten days, the patient at that time only coughing spasmodically.

Case VII.—Multiple shell wounds, involving arms, legs, neck, abdomen and posterior part of chest, the point of entrance in this last mentioned site being near the lower border of the ribs in the anterior axillary line. There was intense shock with cough and dyspnœa. Four days later, the dyspnœa was relieved by the aspiration of one quart of bloody fluid, the patient being evacuated subsequently in excellent condition.

Case VIII.—Shrapnel wound of right chest, point of entrance being in the posterior axillary line below the angle of the scapula. There was cough, dyspnœa and bloody sputum. Two days after the receipt of injury, a half pint of sero-sanguineous fluid was aspirated with relief of both dyspnœa and pain. Evacuated in good condition.

Case IX.—Shrapnel wound with point of entrance in the right posterior axillary line on a level with the inferior angle of the scapula. X-ray showed foreign body moving with respiration. There was marked emphysema with pneumohæmothorax and constitutional symptoms of infection. On the third day one and one-half quarts of foul bloody fluid with much air were removed by aspiration. Although relieved somewhat of pain and dyspnœa, the septic condition continued unabated, the patient dying on the following day from the original hemorrhage and sepsis. In this patient an immediate thoracotomy under a local anæsthetic might have proved of value. It was not done owing to the serious nature of the patient's general condition.

Case X.—Foreign body with point of entrance in the back of left chest penetrating both the pericardium and the left pleura, and seen on X-ray to move with the heart. The physical signs indicated an increasing amount of the fluid contents of both serous spaces, and forty-eight hours after the receipt of injury one and one-half quarts of bloody fluid was withdrawn from the pleural cavity. The patient was evidently progressing satisfactorily when death suddenly occurred eight hours later from cardiac failure. Unfortunately no autopsy could be made.

Case XI.—Shrapnel wound of left chest with marked hæmothorax. Three days after receipt of injury a small amount of clotted blood was removed. Two days later, as marked cyanosis

continued and another attempt to aspirate failed, a thoracotomy was done by Doctor Budington under cocaine with immediate great relief of dyspnœa and disappearance of the cyanosis. Evacuated on the twenty-seventh day in excellent condition.

Cases XII, XIII and XIV present no special features of interest. In all one quart of blood was removed on the third (two) and fourth days, respectively. All recovered and were evacuated in satisfactory condition.

Cases XV, XVI, XVII and XVIII.—These patients recovered and were evacuated, but neither the amount of blood removed nor the time of aspiration are mentioned in the history abstracts.

THE DELAYED OR LATE EXTRACTION OF INTRATHORACIC PROJECTILES BY THE METHOD OF PETIT DE LA VILLÉON *

By Robert G. Le Conte, M.D.
of Philadelphia, Pa.

This method was developed, shortly after the beginning of the war, by radiologist Le Coniac and surgeon Petit de la Villéon at the French Naval Hospital at Brest, and since their departure the work has been continued by Doctors Corolleur and Robin with equal success.

The method depends upon the localization of the projectile with regard to its anatomic surroundings, in contradistinction to its mathematical situation from surface markings. The localization is made through the fluoroscopic screen and not by pictures, and the extraction is also made by sight with the aid of this screen. The anatomical localization is made with the patient standing, and the permanent situation of the shadow of the projectile by frontal and lateral examination will indicate its intrathoracic position. For example:

(1) The displacement of the shadow downward during inspiration, following the diaphragm, and upward during expiration, *i.e.*, in reverse direction to the movement of the ribs, shows that the projectile is in a freely moving lung.

(2) If the shadow follows the movement of the rib, the foreign body is in the lung adherent to the rib or in the pleura.

(3) When in that portion of the lung which lies in the costodiaphragmatic angle, by turning the patient there will always be a position in which the projectile will be viewed clearly between the shadows of the diaphragm and the thoracic wall, and separate from these shadows.

(4) If the projectile is in the cul-de-sac and adherent to the pleura, it will follow the movement of the ribs or diaphragm, to whichever it is adherent.

(5) The projectiles on the dome of the diaphragm are localized without difficulty, but where the shadow of the foreign body is continuous with the shadow of the diaphragm, the question of anatomical localization is difficult, for it may be imbedded in the diaphragm, or sub- or supra-diaphragmatic. Sometimes its exact localization cannot be determined without an exploratory operation, either by the abdominal or thoracic routes.

(6) When the shadow is in the quadrilateral space bounded by the internal borders of the scapulæ and the fourth to the eighth ribs, its anatomical position with regard to the great vessels and large bronchi at the root of the lung is most important. On a lateral view the hilum

* Read before the American Surgical Association, June 17, 1919.

of the lung will be between the plane made by the anterior portion of the bodies of the vertebræ and the posterior shadow of the plane of the heart. If the shadow of the foreign body lies posterior or anterior to this space, the projectile is imbedded in the lung at a safe distance from the hilum, and may be readily extracted without danger, no matter what its depth may be from the costal margin. Above the fourth rib and below the eighth rib it is also in an easily accessible region. Extractions from the hilum of the lung will be discussed in a later paragraph.

(7) In the left chest the relations of the "éclat" (shell fragment) to the pericardium and heart must be exactly determined, and if it moves with the heart beats and fails to move with respiration, extraction by means of the fluoroscope should not be attempted, and an open operation is indicated.

After the standing examination, the patient is examined lying down, to verify the information already obtained. While this anatomic localization is being made, the route by which the extraction will be made is also carefully considered, especially with regard to the tissues that must be traversed to reach the projectile. The shortest route is not always the best, and a lateral or oblique approach is preferable, because it gives to the hand of the operator, held in a horizontal position, greater freedom of motion for manœuvring the forceps, and permits a constantly clear view of the projectile and the end of the forceps in the fluoroscopic light.

This method depends, therefore, upon the exact anatomical localization of the projectile, and upon its extraction with forceps through the smallest of openings, in which the tip of the forceps is constantly in sight, and its guidance to the foreign body is directed by the change in relation of the shadow of the forceps and the shadow of the projectile, the patient lying on a movable table. Whichever of these objects lies nearest the tube, the larger will be the arc of its movement on rotating the patient.

To one who has not seen the method practised by a master hand, the operation may seem uncertain and hazardous. I had this feeling before making my first visit to l'Hôpital de la Marine de Brest, but I left the hospital a thorough convert to the method. Later I was permitted to make some extractions of foreign bodies from the extremities. In this institution about 4000 projectiles have been removed from various parts of the body by this method. In the extremities these extractions were so easy and rapid that it led Petit de la Villéon to try it in the lung. This was done for the first time October 27, 1915, with perfect success.

Technic of the Operation.—The patient is bound to a table, the surface of which can be rotated on its long axis, with the X-ray tube beneath, and an iris diaphragm for the concentration of the light on a given point. The patient is anæsthetized while the room is light. The lights are then turned off, and when the pupil has reacted to the darkness, the X-ray is turned on, the projectile inspected, and the point of approach noted on

the skin. The light is turned on, and with a bistoury a small stab opening is made to the pleura, just large enough to admit the forceps. The point of the forceps is placed in this cut, the lights are shut off and the X-ray turned on. By gentle pressure the closed forceps are forced toward the projectile, and the two shadows are correlated by movements of the table. When the "éclat" is reached it is gently freed from its bed of surrounding tissue with the closed blades of the forceps, and when completely movable the forceps are opened and the object grasped in such a manner that any existing sharp edges or points will cause no damage to the surrounding tissue during the extraction. After the removal, the pleura is carefully inspected for a moment or two for hemorrhage. The light is turned on and the wound dressed with sterile gauze. The technic is simple but highly specialized, and three things are essential for the successful practice of the method.

1. The radioscopic eye must be acquired.

2. The correlation of the two shadows made by the foreign body and the point of the forceps. This must be intuitive, without process of thought, as a dentist works by mirror or direct sight.

3. Gentleness and dexterity of the hand. This is acquired by the removal of projectiles from less dangerous zones, as in the extremities.

The principle underlying the success of this method depends on the fact that a closed forceps can be made to traverse a healthy lung without injuring the vessels or bronchi, as these important structures will be pushed aside when gentle force is used. The danger from hemorrhage will come during the extraction, when the projectile is considerably larger than the diameter of the forceps, or its cutting edges are not protected by the blades of the forceps. The passage through the lung to the projectile must be a straight one, and the making of V or Y passages must be avoided. For superficial foreign bodies, an ordinary hæmostatic forceps is used, but for those lying deeply in the lung the alligator jaw forceps is preferable. The forceps should snugly fit the opening through the thoracic wall, to avoid the production of a pneumothorax, for with air in the pleura a freely moving lung slips away from the forceps. In the hands of an expert two or three minutes will suffice for the removal of superficial "éclats." Those imbedded in the depth of the lung will take a little longer time.

Anæsthetic.—The patient is put to sleep with the lights on, but during the operation the anæsthetic is continued in the dark. The French use ethyl-chloride in a closed inhaler for short operations, but if the operation is prolonged beyond a few minutes they add chloroform. In the United States ether will be preferred to chloroform, but it must be remembered that it is slightly more irritant to the lung. The absence of light requires an experienced anæsthetist.

The Incidents During Extraction.—A little air may enter the pleura through the cutaneous opening with a slight whistling noise. Slight

hæmoptysis may occur, or the patient's saliva be mixed with blood. Slight hemorrhage into the pleura from the zone of extraction is not infrequently observed. It will be seen through the screen as a light shadow the size of a quarter, which may increase to the size of a dollar. This should be observed for a sufficient period of time, to be assured that a rapid hæmothorax is not developing. All of these incidents in Robin's capable hands were without importance.

After Care.—The patient is put to bed and given a sixth of a grain of morphia and an injection of antitetanic serum. In war wounds all deep scar tissue or imbedded projectiles are potential harbors of tetanus bacilli. During the first twenty-four or thirty-six hours there is usually a slight elevation of temperature. Coughing is prevented or controlled by codeine. The expectoration will be tinged with blood for two or three days. Sometimes a little subcutaneous emphysema will develop around the wound. In a week the patient is out of bed. It may then be noted that there is a slight diminution of respiratory movement, due perhaps to pleural adhesions or to pain in the region of the wound. Respiratory gymnastics should then be used. At the end of a month the patient is ready to leave the hospital.

Projectiles in the Hilum.—The removal of foreign bodies from this region of the lung will always be attended with danger, no matter what method of operation is employed. The localization of the "éclat" in this area has already been described, and careful consideration must be given to the route by which the extraction will be made. As the first step in this operation a portion of one rib is resected, and the pleura incised for an inch or more in extent. Should hemorrhage occur after the extraction, the field for controlling it with a gauze pack is prepared in this way. When the projectile lies in the posteror half of the hilum of the lung, a posterior thoracotomy is done, and after opening the pleura an alligator jawed forceps is carefully guided to the projectile under the fluorescent screen. If hemorrhage occurs, it is controlled by packing and the wound left open. If it does not occur the incision in the thoracic wall is closed by suture.

The dangerous zones from which projectiles should not be removed by this method are the mediastinum, pericardium, heart, the medial region of the diaphragm, and the left diaphragm, unless the missile is clearly supra-diaphragmatic. In these regions an open operation is safer, when it is deemed advisable to remove the projectile.

Statistics.—During the October, 1918, meeting of the Congress of French Surgeons, Petit de la Villéon reported about 330 and Robin 92 extractions of foreign bodies from the chest. There were four deaths in these combined series, a mortality of a little less than one per cent. One death was apparently due to the anæsthetic, and one occurred from sepsis, in a patient who had previously had an open operation on the opposite lung, and the autopsy disclosed a putrid gauze pack in the pleura. I can only

analyze Robin's 92 extractions, as Petit de la Villéon's statistics are not available for the moment. The above case with the putrid gauze pack was Robin's only death. Three of his cases developed hæmothorax. (1) The hemorrhage reached the level of the seventh rib, and recovery followed without operative interference at the end of a month. (2) The hemorrhage was more profuse, requiring three aspirations of 200, 250, and 800 grammes of blood. Recovery followed without further incident, beyond a stay of four months in the hospital for pulmonary gymnastics. (3) A small localized hemorrhage developed into an empyema requiring a costal resection for drainage. Recovery followed in three months. One other case developed an empyema on the twelfth day without previous hæmothorax, and recovery followed the excision of a rib. The danger of purulent pleurisy is not from the exterior, as in an open operation, but from the interior, when infection exists in the tissues surrounding the projectile. That this danger is infrequent is shown by Robin's statistics. Theoretically its infrequency may be explained by the rapid closure or sealing of the punctured wound in the lung, and the draining of the infected cavity by a bronchus. Such drainage would probably be unnoted in the sputum, but that it can occur would be shown by the hæmoptysis which frequently follows the extraction. It may, therefore, be an added factor of safety in the operation.

Indications for Operation.—Intrathoracic projectiles should be removed when the patient complains of pleurodynia, shortness of breath on slight exertion, cough or dyspnœa, more or less frequent hæmoptysis, and when there are signs of congestion in the lung surrounding the projectile, with slight elevations of temperature. When no symptoms referable to the projectile exist, the question of its removal should be considered with reference to the possibility of its causing future trouble. Also, "éclats" should always be removed from a military patient, where their presence prevents him from re-entering Class A. When the projectile lies in the mediastinum or hilum of the lung, its size and the degree of tolerance must be carefully balanced with the danger of its removal. In the average case the intervention is so simple, the extraction so easy, the recovery so prompt, and the risk so small, that due weight must be given to these things when the subject of operation is under discussion.

CONCLUSION

1. This method is by far the easiest and most rapid way of extracting a foreign body from the lungs.
2. It is the most certain and direct way of reaching the projectile.
3. It is free from operative shock.
4. It traumatizes the least possible amount of tissue.
5. It reduces post-operative sequelæ to a minimum.
6. The recovery is rapid and the mortality low.

It will not demonstrate fragments of clothing which may have been carried in with the projectile.

Extractions of foreign bodies from the lung should not be attempted by the surgeon until he has served an apprenticeship with an expert radiographer, has acquired the necessary dexterity of hand, and has learned to correlate intuitively the shadows of the projectile and tip of the forceps.

THORACIC FISTULA AND CHRONIC EMPYEMA *

A NON-DEFORMING OPERATION FOR ITS CURE

By Howard Lilienthal, M.D.
of New York

Chest-collapsing operations for the cure of sinuses following empyema are, except in rare instances, unjustifiable and unsurgical. Not only are they followed by permanent thoracic asymmetry with its train of compensatory pathology but the function of a large part of the breathing area of the lungs is practically destroyed. By these operations the attempt is made to bring the mountain to Mohammed—the immobile to the mobile—in a panicky effort to obliterate the pneumothorax at any cost.

The method here to be described will restore the lost pulmonary function and close the thoracic fistula without seriously reducing the capacity of the diseased side. Its danger in my hands has been far less than that of the Estlander, Schede, Wilms or Delorme operations and it needs but a single demonstration to convince one of its many advantages. It is not a "one-man" operation, nor is there required special skill in carrying out its technic, though a single practical demonstration is preferable to the most painstaking paper description.

THE OPERATION

1. *Anæsthesia.*—The intrapharyngeal method, while not indispensable, is of such value and is so simple that its adoption in these cases is advised. If ether is used it should be contained in a suitable bottle with two short tubes in a perforated stopper.[1] Neither tube should extend below the surface of the liquid. A dental foot bellows, or, lacking this, a paquelin bulb, will furnish the air current, a second tube of about fourteen French calibre leading from the bottle to the patient. Three and one-half inches from the end of this second or breathing tube there should be a mark and the tube should be inserted into one nostril not farther than this. If the nitrous oxide and oxygen mixture is used the bellows will not be needed, the force of the current being regulated by means of the cock, the gas passing through the wash bottle. The patient is first put to sleep in the usual way and the intrapharyngeal differential pressure is supplied only when it is called for by the operator. I am speaking here of the chronic empyema in which old adhesions have steadied the mediastinum so there is no to-and-fro flapping, with the attendant cardiac and respiratory dangers. (In recent wounds of the thorax when no lymph desposit has formed

* Read before the American Surgical Association, June 16, 1919.

[1] An excellent stopper with cock arranged so as to switch to ether or air has been devised by Dr. Wm. Branower, of New York.

it is necessary to employ intrapharyngeal pressure throughout the operation.[2])

Position.—The patient is placed over a pillow and on his sound side in a scoliotic posture, the intrapharyngeal positive pressure aiding respiration should there be embarrassment. The hips and knees are flexed, a pillow is placed between the knees and a strap from under the table maintains the attitude, the patient being further steadied by sand pillows at each side.

The incision is in the seventh or sixth interspace and by preference should not enter the old drainage wound. It begins behind the costal angle and extends almost or quite to the cartilage. Part of the latissimus dorsi must be divided and it is well to cut between ligatures the vessels which traverse it. A part of the serratus magnus is treated in the same way. The subscapular and the long thoracic vessels are now easily seen and tied before they are cut and the hemorrhage thus controlled is insignificant.

Entering the Thoracic Cavity.—The knife now divides the intercostal structures at the middle of the wound by an incision about two inches in length close to the upper border of the lower rib, taking care not to injure possibly adherent lung. This incision is now lengthened forward and backward with stout scissors until a sufficient opening has been made to separate the ribs by blunt traction, exposing enough of the interior to work safely and keep clear of the lung. The opening is then further enlarged until it is the full length of the cutaneous wound, when a powerful rib retractor—De Quervain's or the writer's—is placed in position and the ribs separated gradually as far as seems safe, usually about three inches. It is possible that the intercostal artery may now be wounded behind the costal angle, but through this large incision the vessel is easy to secure.

In these old empyema cases the chest wall is firmly fixed by fibrous tissue, so that it is necessary to divide from one to three ribs upward or, sometimes, downward, at the posterior angle of the wound; or, very rarely, upward at its anterior end, in order to expose every recess of the cavity, the skin incision being continued upward or downward from the posterior or anterior angle. The blades of the retractor can now be separated six inches or more. A second rib spreader may even be placed in the vertical part of the wound, further enlarging the exposure. In dividing these ribs it is well to use a Liston's forceps, cutting *slowly* through the periosteum and soft tissues at one stroke. The blades of the forceps are closed upon the edges of the rib, not upon its surface (Fig. 1). The vessels rarely bleed and often are not divided, though the bone is cut by the crushing force employed. If necessary, however, they may be secured by a hæmostatic stitch and divided with scissors after the section of the bone. When ribs have been cut at the posterior angle of the wound, it has been my custom before closing the thorax to cut away about half or

[2] See note at end of paper.

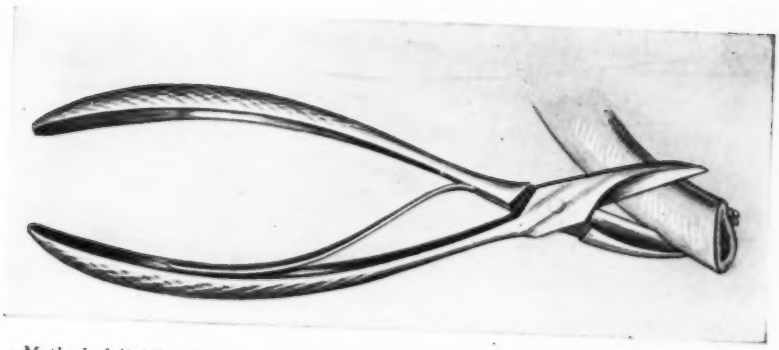

FIG. 1.—Method of dividing ribs together with periosteum and the structures of the costal groove. Note that the forceps is held so as to cut through the rib in its longest diameter.

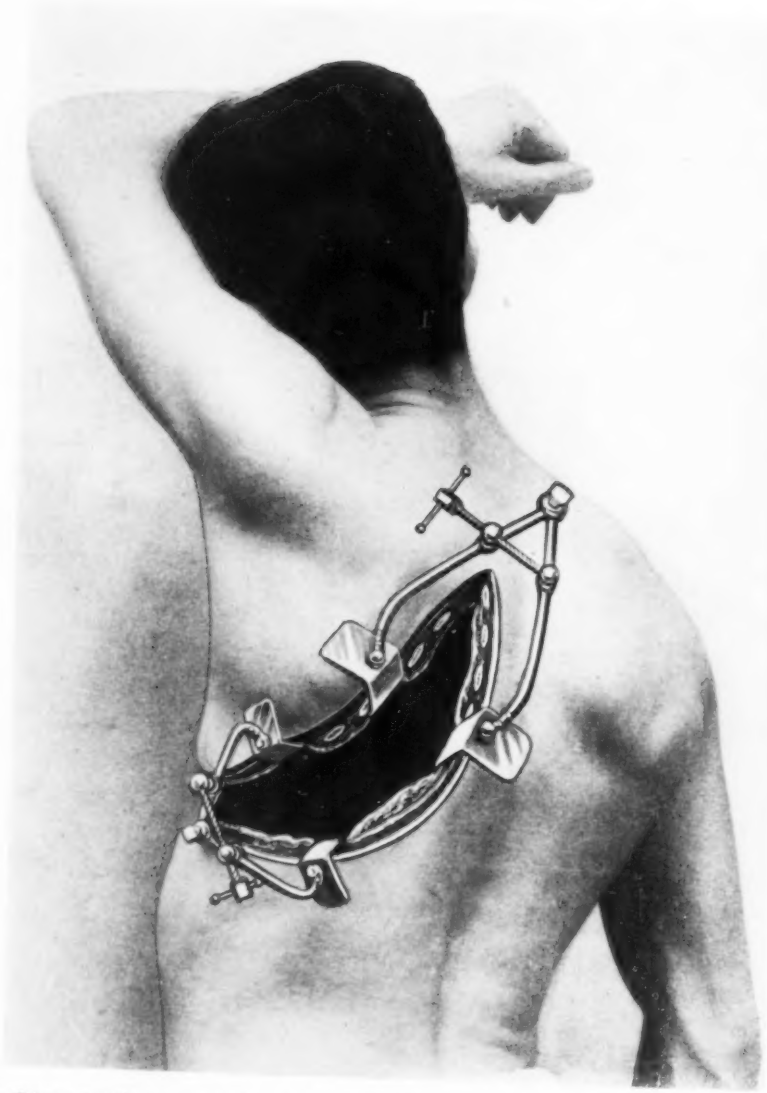

FIG. 2.—Diagrammatic representation of the incision seen from behind. Two rib-spreaders are being used. This is a convenience, not a necessity. One rib-spreader is all that is actually needed.

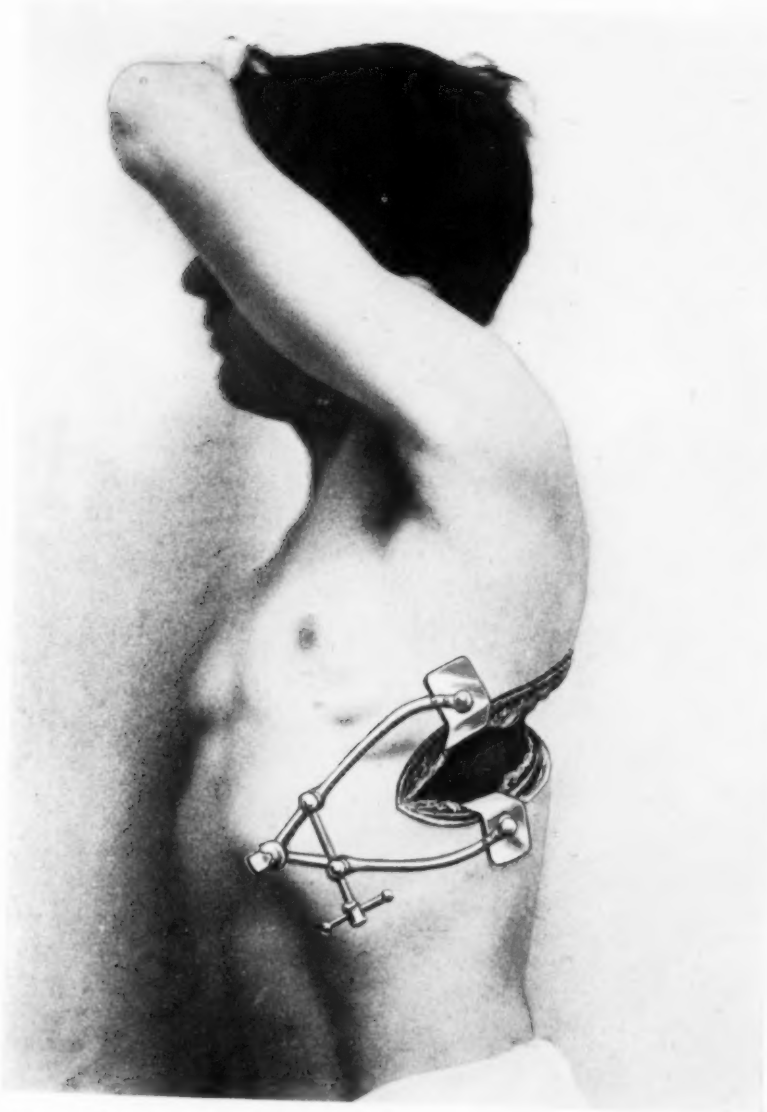

FIG. 3.—Diagrammatic drawing of anterior part of wound. Rib-spreader in position.

FIG. 4.—Illustrating function of arm and shoulder four weeks after the operation. No counter opening was made in this case. The scar is so faint it was necessary to line it on the photograph.

three-quarters of an inch of the anterior portion of each rib beyond the place of its division so as to prevent post-operative pain and trauma by the grinding together of the cut ends.

Mobilization of the Lung.—With the rib retractor in position every part of the empyema cavity lies revealed before us. Often it will appear as if there were no lung in the chest, the entire organ being compressed into the angle between the ribs and the bodies of the vertebræ. All landmarks are usually found to be obliterated, and on wiping away the pus and loose tags of lymph the wall of the cavity is seen smooth, glistening and of a grayish color. With a scalpel an incision is now made into the visceral portion of this membrane from the apex to the base of the cavity, taking care not to wound the lung. This incision at once widens spontaneously and an attempt should be made to find the line of cleavage between the membrane and the pulmonary tissue, dissecting bluntly with instruments or finger. Second incisions at right angles to the longitudinal one will permit further expansion and the loose tags of membrane may be cut away. The anæsthetist now insufflates the lung by closing the free nostril and holding the patient's lips together while the air or ether vapor is forced through the intranasal portion of the tube. If this tube is not more than three and a half inches long air will not enter the œsophagus and the lung will expand, almost or quite filling the chest cavity. Fine bubbling upon its surface is no cause for alarm but a distinct hissing sound means that a bronchial branch has been opened, an accident which in very old cases cannot always be avoided. These fine bronchial openings may lengthen the time of healing, but in my experience they have always closed without further operation. The lung, even though it has been confined for months, will nearly always yield to this treatment, but it occasionally happens that fibrous processes extend down into the pulmonary tissues so that it is impossible to peel away the membrane. Cross hatching by multiple incisions down to the lung as described by Ransohoff should then be made and sufficient expansion can usually be secured. All parts of the cavity, especially the part near the apex, should be carefully inspected and secondary pockets smoothed out into the main chamber. The adhesion of the lower lobe to the diaphragm must be treated with great care, the attenuated flat pulmonary flap being often mistaken for the diaphragm or, still worse, *vice versa.* As a rule, it is unnecessary to peel any part of the lung from the chest wall and it is unwise because of possible hemorrhage and also because the denuded part of the parietes is much more prone to infection than is the lung itself. When it is evident that no further expansion can be secured the tract of the original thoracotomy wound is well curetted and a tube is drawn through from within outward by a dressing forceps. This tube should have two perforations near its inner extremity and should extend only a short distance into the thorax. The large wound is now closed in three layers, using chromicized catgut interrupted sutures for the muscles, and silk

or silkworm gut for the skin. No pericostal or percostal sutures are desirable. The ribs in these old cases do not at once fully approximate, but in drawing together the muscles an interspace of about one and one-half inches is left, and through this opening the outer wound drains into the thorax and thence out by the tube, the cutaneous wound closing by a linear scar.

When the patient leaves the table the lung will again have partially collapsed and during the after-treatment the patient must aid expansion by repeated blowing exercises. I have found that an ordinary rubber cushion or pillow with a tube attached to its valve opening makes an excellent apparatus for this purpose. A ligature tied around the tube to stricture it forms a good resistance. The presence of a bronchial fistula greatly impedes progress, but unless it is very large it need not cause failure. In such cases Beck's paste or a 10 per cent. bismuth vaseline ointment may be injected when the wound has healed down to a sinus. Prompt closure is the rule.

After-treatment.—Shock is rare after this operation and ordinarily the blowing exercises may be started within the first twenty-four hours. And after three days the cavity may be cautiously treated by the Carrel-Dakin method, injecting not more than one-half ounce of the fluid every two hours, night and day. The first sign of coughing or bronchial irritation must be the signal for the instant discontinuance of the injection, for this means that the fluid or its liberated chlorine has entered some minute and unsuspected bronchial opening. It is necessary, too, that there should be a free opening for reflux. Five or six days after the operation, vertical fluoroscopy should be performed and notes taken on the mobility of the lung when the patient coughs or strains. The discharge will gradually diminish and in five to seven days the tube may be left out. The usual time of healing is about four weeks from the day of operation. Occasionally the drainage opening will close without the complete obliteration of the cavity, as is sometimes the case when acute empyema is treated by Carrel-Dakin disinfection, and, rarely, the fistula will reopen, only to close again in a few days. The severed rhomboids and the other muscles quickly and firmly unite, so that the writer has seen no permanent impairment of arm or shoulder function (Fig. 4).

Selection of Cases Suitable for This Operation.—Patients with cavities and discharging sinuses persisting for more than two months after drainage for empyema and unsterilizable by the Carrel-Dakin method should be examined with the vertical fluoroscope. Those with large rigid cavities and profuse discharge are proper subjects for this operation, which may be described as Major Non-collapsing Thoracoplasty. Small cavities when resisting other treatment are also suitable for this form of thoracic surgery including the full exploration of the thorax in trauma, by careful two-hourly flushing with Dakin's solution for five or six days before operating, but never should this cavity be filled—much less dis-

tended—by the antiseptic liquid. A fine tube should be employed with free space alongside, or an additional short tube should be inserted to prevent retention. The main tube may be as long as the cavity and open at the end, without lateral fenestræ. Inject slowly and always be on the lookout for symptoms of "gassing."

NOTE.—I am aware that some surgeons do not consider differential pressure a necessity in thoracic surgery. And in operating upon certain war wounds in which constant traction is made upon the lung by the operator, the mediastinum is steadied so that ordinary exploration and the removal of foreign bodies can be safely accomplished.

In old infected conditions also the positive pressure is hardly necessary except to test the pulmonary expansion; but in all other forms of thoracic surgery including the full exploration of the thorax in tramua, in resection of lobes and in operations upon the œsophagus or other intrathoracic organs, the writer is convinced that the omission of some form of differential pressure will greatly jeopardize the patient.

APPENDIX: EXTRACT OF MILITARY REPORT

Authority to publish granted
Board of Publication, S.G.O.
(*Signed*) Loy McAfee, Sec., M.R.
Date 6/23/19

From: Lieut.-Colonel Howard Lilienthal, M. C., N. A.
To: The Chief Surgeon, American E. F.
(Thru Director of Professional Services)
Subject: Report on Empyema at Base Hospital No. 101.

1. Arrived at Base Hospital No. 101, on Par. 1, Hospital Order No. 153, B. H. No. 3, July 9, 1918.

2. First examination of patients July 10, 1918. There was an "Empyema Ward" with 31 patients all having thoracic sinuses following rib resection and drainage for empyema. These were the patients remaining from a total of 44 nontuberculous cases operated upon in this hospital, or 70 per cent. not well after from six weeks to six months following operation.

At the time of this writing, thirty-six days after my arrival, there are only three of these cases with unhealed wounds.

Ten cases showed pyopneumothorax with sinuses, most of them with copious purulent discharge. These were selected for the thoracoplastic noncollapsing operation (Lilienthal). I demonstrated this method in three cases, the other seven being operated upon under my supervision by Captain (now Lt.-Colonel) James A. Duff, M.R.C., Chief of the Surgical Service. One of the first three patients died—the only one among those operated upon by major thoracoplasty. Six patients are healed, one only three weeks after operation. The others are convalescent with excellent prognoses except one bedridden since his first operation, two and one-half months ago, and not yet out of danger.

Twenty cases with simple sinuses and pneumothorax were treated by disinfecting the cavities, and the wounds soon closed spontaneously.

One large bronchial fistula closed after the injection of bismuth paste for X-ray diagnosis.

3. There was blue pus in every wound in this ward, probably carried by the numerous flies, a nuisance, which, in the absence of screens and because of the proximity of filthy civilian conditions it is difficult or impossible to abate. The pyocyaneus disappeared under daily applications of iodine to the wound and Dakin's solution to the surrounding skin. Even in the presence of infection from within the chest there were but two cases in which the external operative wound had to be drained because of infection, primary union being the rule.

In addition to these ten cases, I have had ten others and three which are still under observation.

One of the latter had been operated upon three times before my own operation which was done on April 21, 1919, just two months before the present note. It was a residual empyema of the mediastinal portion of the pleura in a boy of sixteen. Bronchial fistula was present, greatly impeding the after-treatment. The cavity is diminishing in size, the temperature is on a low plane, although not yet continuously normal, and it is believed the patient will recover.

Two patients died. One, a boy four years old, after nine months' illness. He was operated upon on November 15, 1915, and died within forty-eight hours. Perhaps if the work had been done in two stages he might have recovered. It was a case of staphylococcus areus sepsis. The other death was that of a man forty-three years old, with a left upper lobe chronic bronchiectetic abscess and secondary empyema. He died a little more than a month after the operation, December 4, 1914, of sepsis.

To sum up it may be stated that the procedure here described should be selected in the cases in which it has been heretofore customary to perform major chest collapsing operations or the Delorme-Fowler decortication.

There are no cases of tuberculosis in this list.

EMPYEMA *

By John Stewart Rodman, M.D.
of Philadelphia
Recently Major M. C., U. S. Army, Chief of Surgical Service, Base Hospital, Camp Bowie, Fort Worth, Texas

The basis of this report is founded on the author's experience during service in the Army, first, at the Base Hospital, Camp Bowie, Fort Worth, Texas, from September 15, 1917, to April 1, 1918, and General Hospital No. 14, Fort Oglethorpe, Ga., June 5 to October 10, 1918. During this time approximately 240 cases of empyema came under observation in which I either personally was responsible for the surgical management or supervised it.

In passing, a word might be said as to the arrangement for the management of infected cases in general at these two hospitals. Owing to the pavilion system of building these structures and to a comparatively large staff assigned to the surgical service it was possible to entirely separate the infected from the clean cases. Especially was this management entirely satisfactory at Camp Bowie where a separate set of wards, all on one row, a separate operating staff and operating room were used. A surgeon of experience was put in charge of this group of cases and under him a first assistant and eight ward surgeons, two for each ward set aside for this purpose. This staff gave their entire time and undivided attention to this part of the work. A separate operating room personnel worked with this part of the staff. It was my good fortune while in charge of the Surgical Staff at the Base Hospital, Camp Bowie, to have had Capt. L. H. McKinney, of Colorado Springs, assigned in charge of these cases. He personally performed one hundred and six thoracotomies for empyema before being called elsewhere for duty.

Upon entering the Army the author, with most others, held to the opinion that empyema called for immediate operation. This opinion was based on experience in civil practice with pneumococcus empyema and the experience gained in the Army has in no way changed this feeling. However, we were to deal with a very different type of infection, one that demanded a different plan of treatment and in which, no matter what plan was followed, a much greater mortality resulted. I refer to the empyema caused by the streptococcus hæmolyticus following in the wake of a violent epidemic of measles complicated by bronchopneumonia.

Before going into the surgical management of this extremely interesting type of empyema as it developed in our hands, it will be well to mention several of the other features shown by these cases. It was our melancholy distinction to be stationed at the next to the worst camp in the country from the standpoint of virulence of this epidemic. I refer, of course, to the epidemic of 1917 and 1918, during which in a little more than

* Read before the Philadelphia Academy of Surgery, March 13, 1919.

the three months of November, December and January, one-third of the command of the 36th Division, some 8000 troops, suffered from measles. It was a most pernicious type of measles in that the complications of bronchopneumonia leading to empyema, mastoids and other metastatic infections were common. While it is not our province to go into the epidemiology of this epidemic, a reasonable explanation of the severity of the infection at Camp Bowie may be offered in the fact that the troops encamped there were the Texas and Oklahoma National Guard, made up entirely of men from rural districts, for the most part non-immunes to the respiratory infections.

The pathology of this type of pneumonia was interesting and unlike that of the more familiar type caused by the pneumococcus. Pleural exudates were the rule and formed quickly in the course of the disease. In fact, it was not an uncommon occurrence to find that on the third or fourth day of the disease a sufficiently large pleural exudate was present to greatly embarrass respiration. At this time, of course, the pneumonic process was still in full bloom and the fluid while flaky was clear enough not to be called macroscopic pus but smears and cultures always showed the streptococcus hæmolyticus. The character of the fluid and the fact that the pneumonic process was still active played an important part in the development of the plan of treatment which gave the best results as we shall later show.

The diagnosis was interesting and taxed the watchfulness of the medical side of the hospital. X-ray proved of great value in localizing early collections and those that became "walled off" later on. It was interesting to learn by this means that most of these collections of fluid started to form in the interlobar fissure, and it was a distinct help to the operator to see the chest cavity through the fluoroscope and to mark the chest with blue pencil at the point where the fluid was most apt to be adequately drained.

It was during the early part of November, 1917, that the surgical service began to be called in to deal with empyema. Having, as mentioned before, the strong conviction that even microscopic pus in the chest cavity must be evacuated as soon as possible, especially where respiration was markedly embarrassed, the first fifty cases were treated according to this plan. Many of this group were all but moribund when first seen with a view to surgical interference. In fact, some were actually moribund and nothing could be done. This state of affairs was not due to any laxity on the part of the medical staff most ably conducted by Major J. G. Greenway, but to the severity of the infection and the astonishing rapidity of the disease process. In this first group of fifty cases the plan was followed of draining the chest cavity as quickly and in as simple a way as possible. Accordingly, thoracotomy, without rib resection, was done for the most part under local anæsthesia and drainage provided for with one rubber tube of large dimension. Often this was

done in the ward, as it was not thought wise to attempt moving the patient to the operating room. The mortality in this first group was high and not a few died within several hours of the thoracotomy, enough, in fact, to lead us to believe that this plan of treatment, while apparently based on sound surgical principles and civil experience, was not the one best calculated to deal with this particular type of empyema. Of the fifty cases twenty-three died, a mortality of 45 per cent. Such a mortality was alarming and had we not by then begun to hear of even larger percentages being lost in other base hospitals the prospect would have been most discouraging. The explanation for this high mortality may have been in the several factors mentioned by the Empyema Commission at Camp Lee—the opening of raw surfaces with a consequent blood stream infection or relief of compression of the laboring lung. To me the latter seems most plausible since we now believe that there was a physiological reason for the exudate being present—namely, to splint the infected lung.

It is an interesting fact that quite independently of each other and at about the same time some of those responsible for the treatment of empyema at the base hospitals in the army, changed materially the plan of surgical management. Since even thoracotomy without rib resection under local anæsthesia for some reason often added more to the load that these patients were carrying instead of relieving it, there was only one other procedure simpler still, namely, aspiration. Accordingly, after the first fifty cases we decided to aspirate the worst cases and found to our great relief that this procedure was a distinct advance in treatment. As the fluid was thin at first it was possible after diagnostic puncture had been done to aspirate away by means of the Potain aspirator the greater part of the fluid. The improvement in the general condition, as a rule, was marked, the patients appearing less toxic and respiration became easier. Of course, the chest cavity would soon fill up again and aspiration had to be repeated usually after the lapse of three or four days. However, after the second or third aspiration the general condition of the patient had substantially improved and the fluid taken on the character of frank pus. As we then began to be troubled with reaccumulations of fluid in those in whom early intercostal thoracotomy had been done, owing, we believed, to inadequate drainage, thoracotomy with the resection of one rib as low down as possible, usually in the eighth posterior axillary line, became the operation of choice. The patients also after several aspirations were in much better condition to withstand the shock of this more formidable procedure. The surgical treatment of choice then became aspiration, late operation, and thoracotomy with rib resection. To this we added irrigation after one week had elapsed with normal salt solution and later Dakin's solution. I must confess to having had a prejudice at that time of irrigating an acute empyema cavity which I have entirely lost since.

As a result of this plan of treatment the mortality dropped about half so that in our first hundred cases the mortality, all told, was about 28 per cent., still very high as compared to that experienced in handling pneumococcus empyema.

The plan of aspiration and late operation with rib resection was firmly established with us after trial in our second fifty cases and was not changed in the second hundred. To this plan, however, was added routine irrigation with Dakin's solution every three hours through the permanent drainage tubes, as irrigation with salt solution seemed to add little or nothing to speeding the convalescence. The chest cavity was filled with Dakin's solution and the patient turned on his side for a few minutes and then the fluid allowed to run out. This was a distinct advance in that the character of the discharge changed, lost its purulent nature and assumed more of a viscid appearance. The toxæmia also seemed to more rapidly disappear. Even with the irrigation added our great problem became not so much the mortality as the morbidity. Accordingly, these patients were given open air treatment even more than formerly, and setting up exercises carefully conducted by a medical officer were added as soon as convalescence was established. Such exercises were a material help in shortening convalescence and in leaving expanding lungs, instead of the rigid fixed ones as was the rule before such systematic exercises were established. I now believe that irrigation with Dakin's solution also had a good deal to do with dissolving fibrin and hence preventing adhesions. To recapitulate, then, the plan of aspiration, late operation, rib resection, usually under light chloroform anæsthesia, irrigation with Dakin's solution, and setting up exercises was followed in 133 cases. The mortality had again dropped, it was about 10 per cent. for this group—a vast improvement over 45 per cent. for the first fifty and 28 per cent. for the first hundred. The average period of convalescence was five to six weeks in this series of 133 cases, but some of the early cases despite secondary rib resections persisted in drainage for two or three months. In all there had been some 233 cases operated on by the surgical service of the Base Hospital of Camp Bowie during the writer's service.

In the spring of 1918 it was my good fortune to take the course of instruction in the treatment of infected wounds at the Rockefeller War Demonstration Hospital, New York. I was much impressed by the technic used there and the results obtained in treating empyema. Their mortality was still too high, some 24 per cent. in a comparatively small group of cases, but the morbidity record was much in advance of any I had seen. I believe that the high mortality was not due to the technic used but to the fact that aspiration was not practiced and all cases operated at once.

The technic developed there is briefly as follows: Wide resection, two to three inches of the eighth or ninth rib in the posterior axillary

line, introduction of four Carrel tubes, two upward and two downward, each tube having twenty perforations, immediate irrigation with .5 per cent. Dakin's solution (full strength) on the table, leaving the wound wide open and packing with gauze soaked in Dakin's solution tight enough to steady the tubes and protecting the surrounding skin with sterilized vaseline. A rather voluminous dressing is then placed over the wound and the patient returned to bed. Instillation of 100 c.c. Dakin's solution every two hours by the nurse and irrigation daily at the dressing complete the procedure. The results of this treatment were striking, the toxæmia almost immediately disappeared, the character of the discharge became less purulent almost from the start. The Dakin's solution dissolved out the large fibrin masses and the wound could usually be closed after such chemical sterilization in from ten days to three weeks. A normally expanding lung remained and the soldier returned to full duty. The marked shortening of the convalescence and the early return to duty was certainly worth the extra trouble which this technic entails. After leaving the Rockefeller Institute the writer was assigned to temporary duty at General Hospital No. 14, Fort Oglethorpe, June 5. The epidemic of pneumonia was over at that time, but during the summer I had the opportunity to try out this technic in eight cases of streptococcic empyema. Of these one died from an involvement of the other side, the other seven, however, making unusually rapid recoveries. In one it was possible to close the wound in eleven days, in another thirteen days, and the remainder averaged from two to three weeks.

The comparison between these cases and some that had been treated by simple intercostal thoracotomy was striking. Some of the latter had drained for months and were forever incapacitated for further army duty. Before closing the chest wound, in order to be well within safety, I made it a practice not only to have had a count of less than one bacterium to five fields, but also to secure negative culture. After this brief added experience I now believe that this technic, in conjunction with aspiration and late operation, is ideal in spite of reports of hemorrhage and bronchial fistula, mostly from the army overseas. Strangely enough, I have encountered these complications but once, and that in my last case, operated upon at the Presbyterian Hospital, since my discharge from the Army. This patient did develop a bronchial fistula because of which Dakin irrigations had to be stopped, and six days after discontinuing the Dakin's solution, had a rather severe hemorrhage from the lungs which was repeated several times. He made a satisfactory recovery, however, and I am loath to believe that the bronchial fistula and hemorrhage resulted from the Dakin's solution. These complications have not arisen in the series treated at the Rockefeller Hospital and they do occur, we know, in cases where Dakin's irrigations have not been used. Needless to say, if a bronchial fistula already exists the use of Dakin's solution in the chest cavity is contraindicated.

I have not used any of the methods of suction advocated nor made any attempt at preventing pneumothorax, as neither has seemed necessary. Negative pressure as suggested and tried with success by the Empyema Commission, at Camp Lee, may be the final word in the treatment of these cases. It is difficult to see how an improvement can be made, however, in the plan of aspiration, late operation, wide resection, Carrel-Dakin irrigation and secondary closure of the wound.

Before closing it might be well to mention some of the interesting complications encountered in this series of empyema. General blood stream infections were not uncommon and metastatic abscesses were frequently seen. Next to the pleural cavity the place of choice for infection seemed to be the mastoid cells and there were considerably over 100 of such cases operated at the Base Hospital, Camp Bowie, during the epidemic. An interesting metastatic involvement was a suprapubic abscess deep in the abdominal wall. The first case of this sort appeared to have a distended bladder when the tumor was first discovered as there were none of the usual signs of abscess present. Catheter failed to recover more than a negligible quantity of urine, however, and exploratory needle puncture revealed streptococcic pus. Joint involvement was not uncommon and other superficial abscesses were frequently encountered. Post-mortem commonly revealed pericardial involvement.

Altogether we were distinctly impressed with the virulence of the streptococcus hæmolyticus and with its pus producing ability.

THE TREATMENT OF EMPYEMA*

By John A. Hartwell, M.D.
of New York
Director of Surgery, Cornell Division, Bellevue Hospital

The purpose of this brief communication is not to present any original ideas concerning the treatment of empyema, but rather to call attention to the pathology of the disease, and consider in how far the various methods in vogue are sound in conception and technic.

The name "Empyema" is, in itself, lacking in clearness. In current usage it is sufficiently ill-defined to be a source of confusion in discussing treatment. It is not unusual to find such a discussion involving several quite different pathological processes, and any attempt to unify treatment is obviously futile.

Empyema should be used to indicate a purulent exudate within the general pleural space, limited only by the extent of the infective process. Local collections of pus, walled off by adhesions, are intrapleural abscesses or interlobar abscesses, and have no place in this discussion. A communication with the bronchial tubes is a complication of the condition under discussion. An abscess within the lung tissue is another complication. The presence of these complications may not materially alter the treatment needed for the empyema, but it is more than apt to do so, and success or failure of the treatment may in no way depend upon the pathology of the empyema itself.

Again, in considering empyema proper, one is required to differentiate between many important factors. The infecting organism is a matter of the greatest import. One would hardly include in the same category a peritonitis due to a perforated gastric ulcer, an acute gangrenous appendicitis and the migration of the gonococcus through the Fallopian tubes. There are quite as distinct differences between an empyema of streptococcus hæmolyticus and pneumococcus origin as between the peritonities named. Again, the path by which the infection gains entrance into the pleural space plays an important part. It may be by a direct extension of the pulmonic infection breaking in miliary fashion through the visceral pleura; it may be by way of the lymphatics, either in the form of actively growing thrombi in the vessels, or possibly by the organisms following the lymph current, though normally this is probably away from the pleural surface; or it may be simply an expression of a general blood invasion, with the empyema only one manifestation of its extensive outbreak.

Until discussions on treatment narrow themselves to one or another of

* Read before the American Association for Thoracic Surgery, June 9, 1919.

these numerous pathological entities, confusion is bound to be supreme, and routine surgery only chance bungling.

During the past two years empyema has forced attention from a large number of physicians and surgeons who, heretofore, only took a passing interest in it. Its prevalence has been rather in excess of any surgical condition we have been called upon to treat. It has been, to a large extent, secondary to pneumonic processes associated with the influenza pandemic. A majority of these lung infections have been caused by, or associated with, the streptococcus hæmolyticus, which, in ordinary times, is not a prevalent factor. Very much of the discussion concerning empyema has originated with those who have had no extended experience with the disease in former times, and their views have been formulated on but one phase of the subject, without a full comprehension of the diversity of its pathology.

As demonstrated by McCallum,[1] this streptococcus almost invariably invades the pleural surface. Early in the disease, when terminating fatally, there is not only an infected exudate in the pleural cavity, but the visceral surface is covered with velvety granulation tissue. The pleura itself is thickened with œdema and other inflammatory products, and in many instances adhesions between the two surfaces are found. In some instances, as determined by the clinical course, this invasion of the pleura subsides with the pneumonic process, but in others it persists as an empyema after the lung condition is healed. The pathological process when the various types of pneumococcus unassociated with the influenza disease are the infective organisms is quite different from the above. The pleura is much less frequently involved, and when it is, the pleuritis is more nearly a sequella; that is, it begins when the pneumonia is subsiding. The thickening of the pleura at autopsy is found to be much less than in streptococcal infection. This finding, however, is not indicative of the condition when a well-established pneumococcus empyema is present. In fatal pneumococcus pneumonia, death occurs before this stage is reached, and therefore autopsies on such cases show only the pleural lesion of the pneumonia, and not the empyema. If such cases survive the pneumonia, and later die from an empyema, either with or without operation, the pleural membranes show a much more marked thickening. This is also usually present when operation is undertaken comparatively early.

In essence, therefore, empyema in its simplest uncomplicated form is a purulent inflammatory process going on in a closed serous cavity. Under these conditions pus is formed under pressure, and since the thorax is comparatively rigid, there results a compression of its contents. The most easily compressible structure is the lung itself, and this organ loses a part of its air content. At the same time, its delicate serous covering becomes a more or less rigid barrier and offers resistance to the compressing process. This results in forcing over to the other side the mediastrium and the heart, and in many instances depresses the diaphragm. This is the extent of the process

[1] Rockefeller Institute for Medical Research No. 10, April 16, 1919.

in the majority of the cases that occur as sequella to lobar pneumonia under its ordinary occurrence in non-epidemic form. This is the disease for which through many years there has gradually developed an almost standard treatment which has proved most satisfactory and successful in cases not too long neglected.

The treatment was formulated to meet a definite pathological condition. It aimed, first, to establish ample drainage of the large infected cavity, with full knowledge that the infecting organisms would rapidly die out. Secondly, it aimed to obliterate the cavity which had resulted by reason of the compression and misplacement of the thoracic organs. As an adjuvant to these two aims, irrigation has from time to time been in vogue, but by most surgeons discarded. There has also been substituted for an ample drainage opening various types of intermittent or continuous suction, with the hope that the negative pressure thus established would tend to draw out the compressed lung, and thus hasten the cavity obliteration. This negative pressure has been obtained by elaborate apparatus consisting of a canula or tube inserted into the thorax so snugly that no air leakage could occur around it, and a pump or syphon suction. It has had a very thorough trial by many competent men, and has met with some success. More often than not, however, it failed to accomplish the desired end, either because the connection through the chest wall did not remain air-tight, or drainage was incomplete. In part its use is based on a misconception. The belief has been more or less prevalent that when an open thorax is present, the lung, unless adherent, completely collapses because of the tension of its elastic fibres unopposed by a negative pressure around it. This only occurs when the pleural cavity of the lung is not changed by inflammatory exudate, and the opening in the chest is so large that the inflow of air through it in inspiration is equal to that going through the glottis. Graham and Bell [2] have proved this experimentally, and have demonstrated that an opening 2 inches by 4.1 inches can be borne without complete collapse of the lung.

This means that with any smaller opening, each inspiratory effort tends to produce a negative pressure, and by just so much tends to draw air through the trachea into the lung on the affected side. Graham [3] demonstrates that it goes in equal amount in each lung in the absence of inflammatory fixation of the mediastinum. Therefore, if ample drainage is provided through an opening not too large, and this opening is kept largely obstructed on its outer aspect by the application of copious dressings, ideal conditions are present to overcome the infection, and ultimately force the lung to reëxpand to its normal extent. The use of forced inspiration and expiration is a great aid to this process, and is habitually obtained with the blow-bottles. That a proteolytic agent like Dakin's solution intermittently diffused throughout the cavity is an aid is beyond question. It removes the substances on which bacteria live, and at the same time kills bacteria with which it comes in contact, and by just so much shortens the period of infec-

[2] Amer. Jour. Med. Scien., Dec., 1918, No. 6, vol. clvi, p. 839.
[3] Loc. Cit.

tion. It also may aid in digestion of the inflammatory exudate on the pleura, and thus allow earlier lung expansion. Hence, the standard treatment of this disease, gradually evolved over many years, is seen to be based on a very sound reasoning, and succeeds because it accurately combats pathological conditions.

As encountered, however, during the past two years, the disease called empyema has differed from this simple form in many important particulars. It also has been treated by men who have never studied the underlying principles of this standard treatment, and consequently applied it to a very different condition, with inevitable but unexpected failure. To the initiated, the report of a commission was not needed to point out that a wide-open hole in the chest of a man desperately sick with a streptococcus toxæmia, was going to add to rather than diminish the cyanosis from which he suffered. The mechanical embarrassment under which his respiration labored could be as effectively relieved by a simple aspiration. So long as the fluid could be drawn through a needle, this relief could be afforded as often as was required. His toxic condition was also to a degree lessened by this procedure, but this was of minor importance, because the source of the absorbed poisons lay in the lungs, or other tissues, and not in the pleural effusion. Later, if his strength withstood the ordeal, and the purulent exudate continued in the pleural space, the standard operation was successfully performed. In many instances this was not needed, and the infected pleura returned to the normal with no other treatment than aspiration, either intermittent or continuous, sometimes aided by flushing with Dakin's solution through the aspiration apparatus. This was not only feasible, but successful, because of two factors. The fluid throughout the early stages is thin and relatively poor in coagulable substances. Therefore, the chest cavity can be completely emptied through a relatively small canula. The streptococcus hæmolyticus is not a deep invader. It lies close to the surface, and in many resistant individuals, though primarily very virulent, tends to die out. Hence, we repeatedly receive reports of such cases getting well. False inferences were drawn, and a widespread belief exists that the proper treatment of empyema lies in suction evacuation of pus and delayed or no operative treatment. Due consideration is also not given to the fact that no small number of these cases recovered when the exploring needle withdrew a cloudy infected fluid, and no operative treatment of any sort was employed.

It is not difficult to logically explain wherein the less radical forms of treatment fail to meet the requirements of the pathological conditions in a true purulent pleural effusion. In the first place, they do not satisfy the principle of adequate drainage of an active suppurative focus. This law can only be ignored with due caution. A suppurating surface as extensive as the pleura must be given constant and continuous opportunity to be freed from contact with the products of its lesion, if healing is to occur. If by chance—and I believe it is chance—the constant suction keeps the cavity empty, there is always a possibility that a latent infection will subsequently light up and the lesion occur. In the second place, all treatments of this

character are based upon the erroneous idea that the expansion of a lung whose thoracic wall is open cannot take place. Wherein this view is erroneous has already been explained, and as the suppuration grows less, and the drainage opening is permitted, day by day, to contract and is kept more continuously covered with a copious dressing, by a corresponding amount does the expanding force of respiration increase. There is thus an orderly return to the normal, the suppuration lessening as the lung, freed from its crippling thickened pleura, gradually expands, so that full expansion and a clean healthy pleura occur at the same time.

The expected time for the accomplishment of this is from four to five weeks. Any attempt to shorten it by chemical sterilization of the cavity and a tight secondary suture of the opening is doomed to such frequent failure that it cannot be recommended. The explanation is not difficult. Assuming that our bacteriological observation has covered every nook and corner of the infected portion of the pleura—an assumption that takes more credulity than I possess—a closure of the opening leaves a dead space within the thorax. The damaged lung does not immediately leap out to fill this, even under conditions of normal chest expansion. The almost invariable result is a serous effusion into this dead space which in itself prevents by that much the full expansion of the lung. The conditions are, therefore, ideal for a recurrence, namely, a pent-up collection of serum within a serous-lined cavity which recently has been the seat of a virulent infection. The fact that sometimes success is obtained and a final cure results in three or even two weeks does not alter the fact that it is obtained in spite of a violation of sound principles. The failures are more than enough to condemn the procedure, and when they do occur are more difficult to cope with than was the primary disease.

The purpose of the arguments herein presented is to call attention to the fact that if the experiences of the past two years are made the basis of the standard treatment of empyema, under conditions of pulmonary disease less abnormal than those existing during this trial, a distinct step backward will have been taken.

Reading of the history of empyema during the past five decades shows that from time to time there have arisen advocates of the so-called less radical forms of treatment, who have enjoyed a short period of success. Failure, however, always succeeded this period. Gradually, through the constant teaching of thinking masters, this disease has recently been handled along sound lines of therapeutic technic, founded on a full comprehension of its pathology. Any falling away from this will only result in a period of again learning old lessons with its resultant suffering.

Our argument may be summed up in the statement that no form of treatment for empyema which disregards the thorough drainage of the chest cavity by a rib resection, and the gradual reëxpansion of the lung by respiratory effort, meets the requirements. Other means will cure a certain number of cases, particularly in such times as the disease occurs in abortive forms, which it has done during the past two years.

FOREIGN BODIES IN THE STOMACH *

By Randolph Winslow, M.D.
of Baltimore, Md.

The presence of foreign bodies in the stomach, while always of interest, is by no means uncommon. They are found in three classes of persons: First, in those who swallow objects accidentally; second, in insane or otherwise unbalanced individuals, including those who swallow articles with suicidal intent; and third, in mountebanks or professional jugglers, who eat glass and swallow other dangerous objects as a means of a livelihood. The articles that are swallowed accidentally are usually single and smooth, blunt or rounded in character, such as coins, marbles and pebbles, which, if not too large to pass through the œsophagus, will usually also traverse the intestinal canal and be expelled per anum. But sharp-pointed and jagged objects are also swallowed accidentally, as pins, needles, hat pins, open safety pins, plates with artificial teeth and pieces of bone, which may become lodged in the œsophagus, or if they descend into the stomach, may perforate this organ, or if they pass into the intestine may lacerate or penetrate the walls of this tube. A case of this character came under my observation many years ago. A man while eating a chop swallowed the articular process of a vertebra. He was taken with violent pains and soon died. I was able to get an autopsy and found the bone far down in the small intestine, the mucous membrane having been extensively lacerated by a sharp spicule projecting from the bone.

An almost similar case with, however, a more favorable result, was reported by Weishart in the *Münch. Med. Wochenschrift,* vol. lxiii, April, 1906: A woman, while eating, swallowed a piece of calf's rib from which a sharp point projected. This caused violent pains and collapse, but eventually the bone passed per rectum and she recovered.

It is really remarkable that so many sharp and pointed articles do pass through the alimentary canal without producing serious results, such as pins, open safety pins, knife blades, tacks and nails. In this connection the following case is of interest:

> *Swallowed a Nail.*—B. J., boy, aged two and one-half years, on August 17, 1914, swallowed a wire nail. He was admitted to University Hospital in my service. An X-ray examination showed the nail lodged at the cardiac end of the stomach. He did not appear to be suffering in any manner from the nail, nor was there discomfort at any time during his stay in the hospital. On August 22, the nail passed per anum. No purgative was given at any time. Skiagraphs

* Read before the American Surgical Society, June 17, 1919.

were taken daily, which showed the nail passing slowly through the intestinal canal. The descent of the nail as shown by the daily skiagraph was not only very interesting but determined absolutely that no surgical interference was indicated.

Multiple objects are swallowed either by the insane or by mountebanks. The number and variety of articles ingested is great. Practically all of these individuals come to operation sooner or later. Sometimes several years may elapse without any serious symptoms being experienced, but in many cases the reverse of this is true. I desire to place on record here the history of a case of multiple foreign bodies removed by gastrotomy from an insane woman in August, 1918.

Stomach Filled with Pins, Safety Pins and Other Objects.—L. S. was admitted to University Hospital on August 15, 1918. The patient, a Russian Jewess, was admitted to the Springfield State Hospital for the Insane at Sykesville, Md., on November 8, 1916, with the diagnosis of dementia præcox. She is married and is the mother of three children. At the time of her admission to this hospital she had been ill for four months. There was nothing of especial interest in her case from a surgical standpoint until March 29, 1918, when it is recorded that she had nausea and vomiting with a little rise of temperature in the afternoon, but she did not appear to be in pain. She continued to eat well but a month later had to be fed through a tube. She has been losing weight.

May 30: "She has been sticking pins in her ears and vagina, which have to be removed frequently. She has also been found with hair pins and safety pins in her mouth, which are removed with difficulty. There has been some bleeding from the mouth, probably due to trauma from the foreign bodies."

August 8: "She has vomited a brownish material that looks like partially digested blood. She has the same material in the stools. She is kept in bed and is showing marked signs of weakness."

August 12: It is recorded that "There is a hard mass in the stomach, which crackles under the fingers. Vomiting is of daily occurrence, the vomitus consisting of the same dark brown material, which is still found in the stools."

August 15: She was sent to the University Hospital for operation. She is thirty-four years old, and is a thin, undersized woman weighing less than 100 pounds. She cannot, or will not, speak English and we can get no statement from her in regard to her condition. On inspecting her abdomen an elevation is seen in the epigastric region, and on palpating this a crackling sensation is felt. She does not appear to suffer pain to any extent. An X-ray examination shows the stomach to be filled with an immense number of pins, hair pins, safety pins and other objects, with ten pins and a hair pin in the intestinal canal. Her temperature was practically normal.

Operation was done on August 17, 1918, under ether anæsthesia.

A right rectus incision was made, the stomach exposed and lifted partially out of the wound and surrounded with gauze compresses. The stomach was distended and a vertical incision was made into it, in order to avoid the vessels. At first I attempted to pick out the foreign bodies with forceps, but as they were so matted together it was necessary to enlarge the incision and insert the whole hand in the cavity of the stomach in order to dislodge and remove them. This was a difficult and somewhat dangerous process, as there was great liability of lacerating my hand on these sharp pointed objects as well as of puncturing the walls of the stomach. However, I succeeded in removing them entirely. The stomach walls were much thickened and the mucous membrane was inflamed, ulcerated and covered with an exudate. There was quite free bleeding from the mucous membrane. The incision in the mucous membrane was closed with two rows of catgut sutures and the outer walls of the stomach with two rows of silk sutures. The abdominal wound was closed in tiers, without drainage. The patient stood operation well. When she was returned to her bed, Murphy's proctoclysis was instituted. Nothing was given by mouth for forty-eight hours, then coffee ℥i every two hours.

August 20: Milk ℥i and lime water ℥i every two hours.

August 21: Patient is in excellent condition; bowels moved several times. Proctocylsis discontinued and milk ℥ii and lime water ℥ii every two hours allowed.

August 22: Milk ℥iii and lime water ℥iii every two hours.

August 23: Continue milk and give one soft boiled egg.

August 24: Milk with two soft boiled eggs allowed.

August 25: Milk ℥iv and lime water ℥js every three hours and one soft boiled egg three times a day.

August 26: Milk continued and four soft boiled eggs allowed. On this date four straight pins, one straight hair pin and one bent hair pin were passed per enemam.

August 27: Milk ℥v, lime water ℥js and five soft boiled eggs; slight suppuration in wound.

August 29: Six soft boiled eggs and milk as above. One straight pin passed per rectum.

September 1: Soft toast once a day is added to diet.

September 7: Soft diet. Patient has been sitting up for several days. X-ray shows a clump of three or four straight pins in lower bowel, but none in the stomach or in any other part of the intestinal tract.

September 10: Patient discharged to go back to the State Hospital. Subsequent to the operation her temperature was practically afebrile.

The following note was kindly furnished by the State Hospital as to the condition of the patient after her return to that institution:

October 14, 1918: "On September 10, the day she returned, her weight was 76 pounds; on October 12 it was 82 pounds. She is sleeping and eating well, is up and about the ward each day, and appears to be suffering in no respect from her unusual experience. She is kept

FIG. 1.—Roentgenogram showing foreign bodies in stomach of patient (L. S.) before operation.

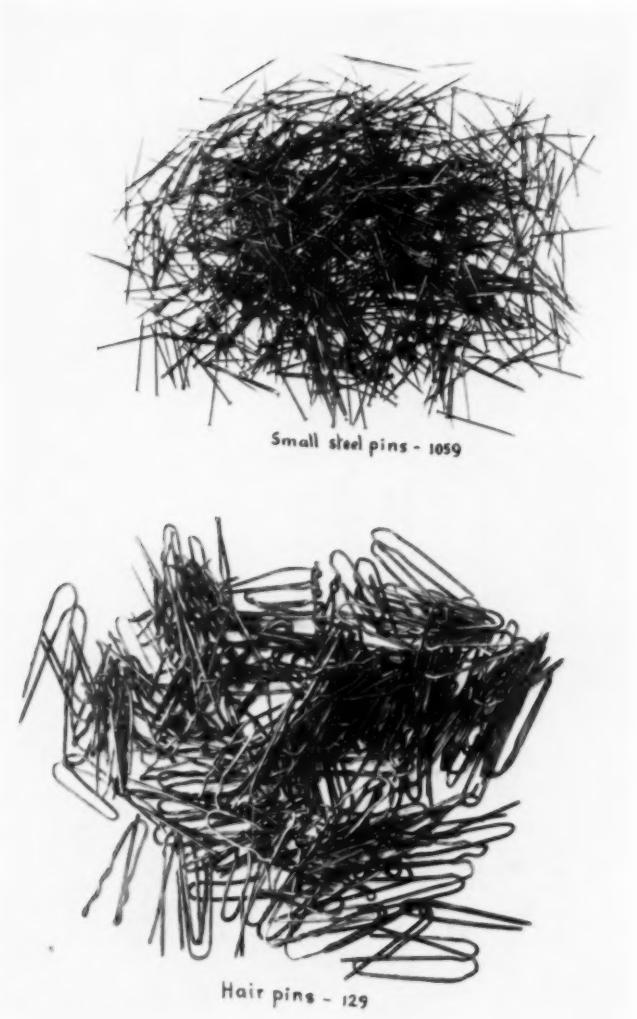

FIG. 2.—Objects removed from the stomach of patient (L. S.), August 17, 1918, by Dr. R. Winslow. Photographed after removal.

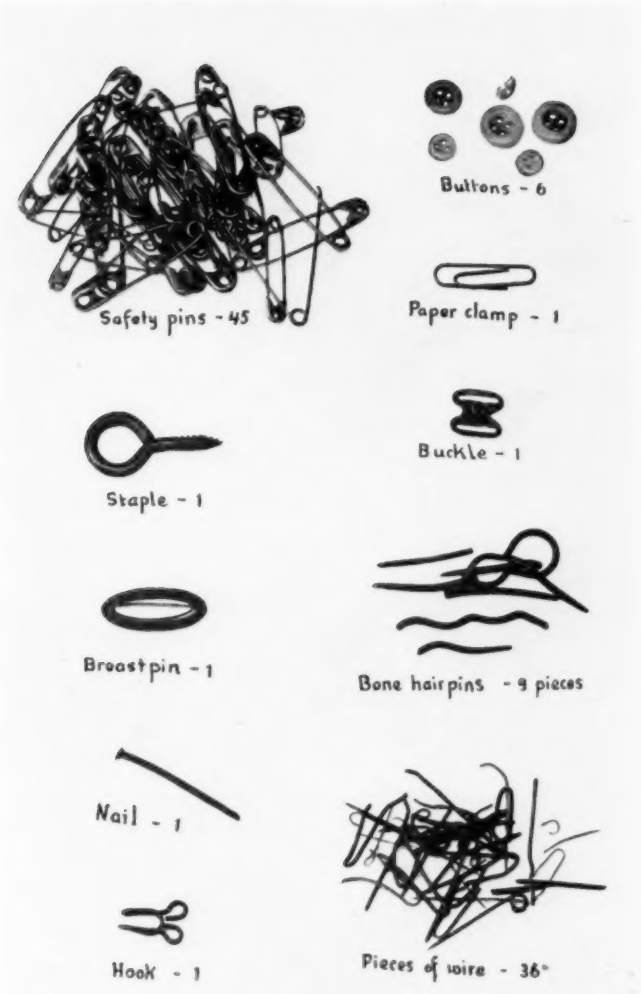

FIG. 3.—Objects removed from the stomach of patient (L. S.), August 17, 1918, by Dr. R. Winslow. Photographed after removal.

under close observation to prevent her from procuring her selected morsels. Mentally her condition is unchanged."

The foreign bodies removed from her stomach numbered 1290 different objects, as follows: Straight pins, 1059; safety pins, 45; hair pins, 129; pieces of bone hair pins, 9; pieces of wire, 36; buttons, 6; iron screw staple, 1; iron hook, 1; wire nail, 1; paper clamp, 1; garter buckle, 1; breast pin, 1. Besides these the skiagraph showed 10 pins and hair pins in the intestines, but at the time of her discharge all but three or four of these had passed naturally. The grand total of foreign bodies in her stomach and intestines on admission as shown by the X-ray and by removal was 1300, most of them sharp-pointed objects that were liable to perforate the walls of the viscera; that they did not do so is surprising. As to the length of time she had been indulging in this practice I am ignorant, but it must have taken a long time for her to secure so many articles, especially as she had been detained in a hospital for the insane, where she would have been under constant observation, a year and a half.

The interest in this case centres not so much in an operation of gastrotomy for the removal of foreign bodies as in the number and the dangerous character of the objects removed. As far as I am aware, this is the largest number of individual objects that has ever been removed from the stomach of the living human being, though Vandivert and Mills report the removal at autopsy of 1446 objects from the stomach of an insane mulatto woman. *Journal A. M. A.*, January 21, 1911, p. 180. There are, however, many remarkable cases of multiple foreign bodies removed by gastrotomy reported in the literature. I shall not attempt to make a statistical report of such cases, but will mention a few of the most remarkable examples.

MEISINBACH, St. Louis (*Jour. A. M. A.*, 1898, vol. xxx, p. 513), removed from the stomach of a mountebank 25 staples, 15 screws, 6 horseshoe nails, 30 wire nails, 19 cartridges and 2 broken knife blades which had been in the stomach nine years.

VON QUAST, Kansas City, Mo., removed from the stomach of a woman 9 ounces broken glass, 2 pocket knives, 1 barbed-wire staple, 5 knife blades, 3 screws, 1 horseshoe nail, 16 tacks and 9 nails. See article by Friedenwald and Rosenthal, *N. Y. Med. Jour.*, July 18, 1903.

HALSTED, Baltimore, from the stomach of a mountebank, 74 grams crushed glass and 208 other objects, including 21 pieces dog chain, 4 watch chains, 1 brass chain, 2 pieces of chain, 10 horseshoe nails, 54 wire nails, 35 ordinary nails, 8 screws, 2 screw-eyes, 7 knife blades, 1 knife handle, 50 tacks, 12 pins, and one piece of tin.—*Johns Hopkins Hospital Reports*, 1900, p. 1047.

INCH, Kalamazoo, Mich., 2 hat pins, 3 hair pins, 2 pieces wire, 1 button-hook minus handle, 1 screw head and 1 brass tack, and the patient subsequently passed handle of button-hook in 2 pieces, 2 carpet tacks, 3 pins, 1 screw, 4 nails and 1 piece wire.—*Jour. A. M. A.*, 1902, p. 603.

WARBASSE, New York, operated twice on a juggler, who was suffering from gastric tetany due to foreign bodies in the stomach, and on each occasion removed a large number of objects, such as nails, chains, etc.—ANNALS OF SURGERY, vol. xl, p. 909.

GAYLORD, Erie County Hospital, removed carpet tacks 453, penknife blades 41, screws 142, pen points 40, wire chain 3 inches long 1, and 6½ ounces ground glass, the whole weighing 2 pounds 3 ounces (l. c. Friedenwald and Rosenthal).

HEINZ MARKS, St. Louis, removed glass, tacks, nails, screws, etc., weighing 16 ounces (l. c. Friedenwald), *Medical Fortnightly*, St. Louis, May 15, 1892.

BALFOUR, Rochester, Minn., *Jour. A. M. A.*, vol. lxvi, p. 421, 1916, removed 7 teaspoons from the stomach of an insane woman.

AUTTEN, St. Louis, 2 gastroliths, weighing 517 grams (l. c. Friedenwald), *Medical Fortnightly*, August 14, 1894.

KORTMANN, 2 shellac stones, weighing 670 grams. This man worked in a porcelain factory and drank an alcoholic solution of shellac, which solidified in his stomach. They had been in the stomach 17 years (l. c. Friedenwald), *Deutsch med. Wochensch.*, 1897, E, No. 26.

Hairballs in the stomach form a large subject and are thoroughly considered by Rudolph Matas in an excellent article published in the *Transactions of the Southern Surgical and Gynecological Association*, 1915, p. 572.

While many single objects pass through the intestinal canal and are safely extruded, multiple foreign bodies usually lodge in the stomach and require to be removed by gastrotomy. At the present time an exact diagnosis is possible by means of the skiagraph and this method of examination will not be neglected by a careful surgeon. The removal of foreign bodies that have lodged in the stomach is a comparatively safe procedure and the percentage of recoveries is very high, even when they have remained in the viscus a long time. Naturally, the sooner they are removed the better the result is likely to be.

INGUINAL HERNIA *

AN OPERATIVE METHOD BY WHICH CLOSE TO 100 PER CENT. CURES HAVE BEEN OBTAINED

By Franz Torek, M.D.
of New York

The method here described was developed by the author fourteen years ago and has, since its inception, been modified only in details of minor importance, so that there has been ample time to test its value and to avoid jumping at any hasty conclusions.

A previous publication, covering my experience in the first six years, with 304 cases that could be traced, was published in the *Medical Record* of June 22, 1912, under the title "A Contribution to the Study and Surgical Treatment of Oblique Inguinal Hernia." A second series of cases, covering about six and one-half years, up to the end of 1917, consisting of 294 cases that could be traced, makes a total of approximately 600 cases, out of which two recurred, *i.e.*, one-third of one per cent. The first of these was described at length in the former article, a patient who developed gangrene of the abdominal wall, later on found to be of syphilitic origin. The second was a healthy man operated by one of my house surgeons, myself not being present at the operation. As the operation for the recurrence was performed by another surgeon, I am unable to give an authentic explanation of the cause of failure in that case, but I may say that, as the staff man who operated never became a surgeon, and as the case must have been a simple one, we may safely infer careless technic to have been the cause of failure. There is no such thing as a fool-proof method. I believe both of these recurrences should have been avoided, the former by a better study of the man's general condition, the latter by closer attention to details of surgical accuracy, and the results ought to have been 100 per cent. cures instead of 99⅔ per cent.

To the question which has once been put to me whether I have selected my cases, I may say that, if there has been any selection, it has been in a sense opposite to the usually accepted one—I mean that, while the most unfavorable cases would surely be selected for my operation, in the simpler class of cases the assistant would occasionally be permitted to operate by any method he chose.

The salient points in the technic of the operation are the following:

1. Clean separation of the vas deferens and the blood-vessels of the cord from each other as well as from the sac by the removal of all the connective tissue that binds them together, allowing the vas to come out at the bottom of the opening in the transversalis fascia and the vessels to come out at the top of it, while the stump of the sac sinks back between

* Read before the New York Surgical Society, March 12, 1919.

the two. A couple of stitches uniting the muscles to Poupart's ligament keep the vas and vessels permanently separated at the site of the internal ring. The introduction of these sutures applies only to the oblique variety of inguinal hernia.

2. Below the vas suturing of Poupart's ligament to the internal oblique and transversus muscles, and often to the rectus muscle, is continued all the way down to the insertion at the pubis. This is of importance in order to avoid recurrence in the shape of a direct hernia, as well as for the repair of one already existing.

3. The employment of non-absorbable suture material at those parts where there is tension, my preference being silver wire.

4. A number of minor points which might properly be classed under the head of "common sense rules." For instance, the approximation of Poupart's ligament and the muscles must be an absolutely clean approximation, without interposition of any such structures as fat, connective tissue, cremaster muscle, etc.; the alignment must be absolutely accurate; the sutures must be sufficiently close to allow no gaping of tissues between them; they must not be drawn so tight as to cut into or through the tissues they are supposed to unite; when there is much tension, the sutures must be laid closer to each other than in the absence of tension; avoidance of rough handling or tearing of the tissues, etc.

Of these points, the one in which my operation differs radically from all others heretofore described is the first point, the separation of the vas deferens from the blood-vessels of the cord and keeping them separated. The studies which led to the adoption of this procedure have been extensively explained in my previous communication and are here summarized in what follows:

Within the abdomen the vas deferens and the blood-vessels of the cord are apart and separate from each other. At the internal inguinal ring they meet at an angle, the vessels approaching the ring from above downward, the vas from below upward (Figs. 1, 2 and 3). At the site where they meet, an open wedge, or infundibulum, exists through which intra-abdominal structures can force their way out, the protrusion being facilitated by this funnel-shaped arrangement. As a matter of fact, when an oblique hernia is formed, it always wedges its way through between the vas and the vessels. The diagrammatic illustrations by some authors depicting the point of exit for an oblique hernia as being below the cord are incorrect.

In oblique hernia, therefore, the arrangement of the structures at the internal inguinal ring is: Vessels above, vas below, sac between them (Figs. 4 and 6). If this relation is not perfectly evident at the time of operation, the cause is that the said structures have not been prepared entirely clear of the connective tissue which binds them together, and the presence of which obscures the anatomical relations. I wish to emphasize that the statement made above as to the arrangement of these structures

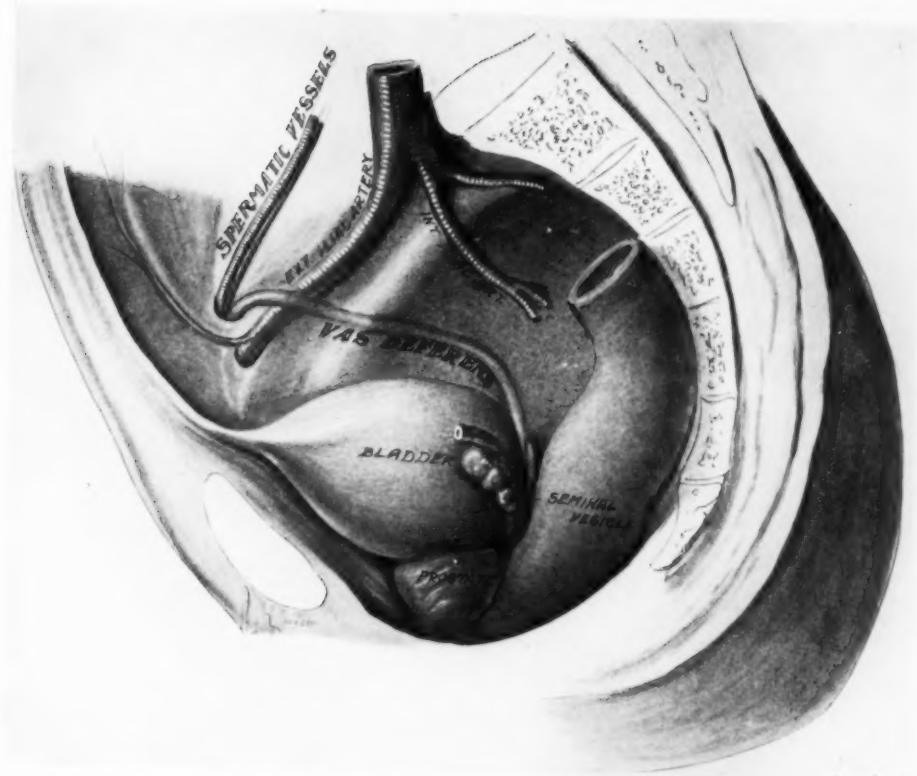

FIG. 1.—(After Spalteholtz.) Interior view of lower abdomen and pelvis showing relation of spermatic vessels and vas deferens at internal ring. Lateral view. Observe that vas and vessels meet at an angle, like the two sides of a wedge, thus facilitating the protrusion of a process of peritoneum (compare Fig. 3) and the development of a hernia. The illustration shows the relation in the normal state; in cases of oblique inguinal hernia the internal inguinal ring is enlarged, the vas deferens and the blood vessels being separated by the interposition of the sac (see Fig. 4).

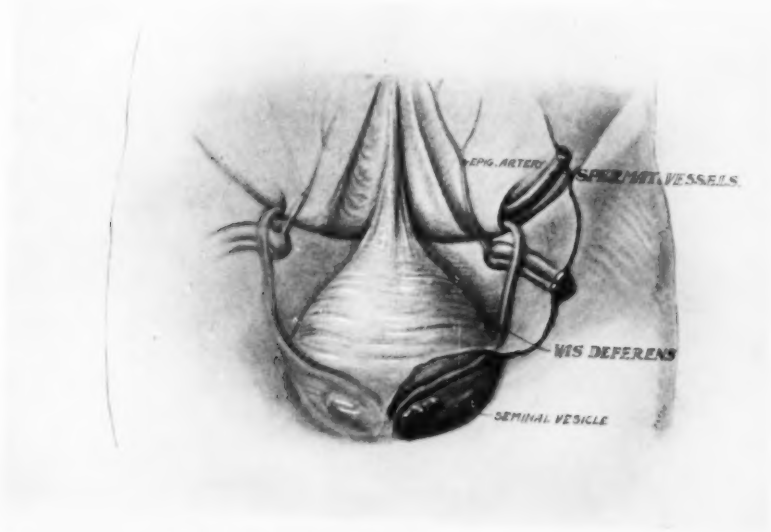

FIG. 2—Same relations as in Fig. 1, seen from behind.

refers solely to *their relation at the opening in the transversalis fascia.* After they have passed beyond that point, their relative position is altered, the sac as a rule lying posteriorly.

The object of the above named "first point" in my operation—separating vas and vessels and keeping them apart—is to deprive the peritoneum and the abdominal contents of the opportunity again to obtrude or force themselves between these two structures, as they could so conveniently do while the wedge-shaped arrangement of vas and vessels existed at the internal ring. This arrangement is abolished by establish-

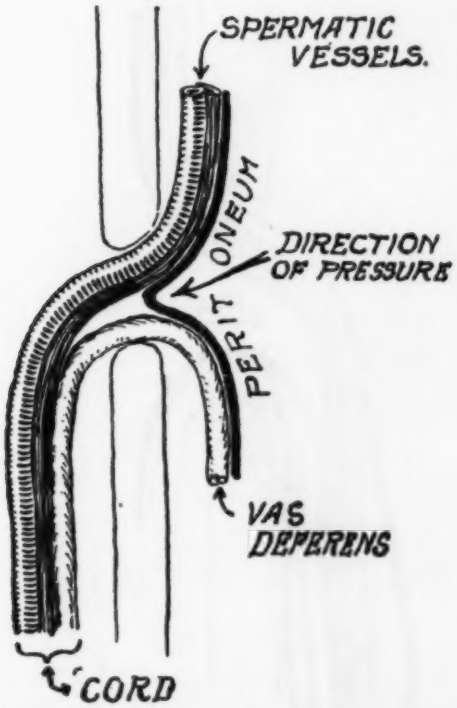

FIG. 3.—Diagram of relations of spermatic vessels and vas deferens at internal inguinal ring. Almost normal, but representing a beginning impingement of the peritoneum into the open angle of the wedge outlined by vessels and vas. Compare remarks under Fig. 1.

ing a firm, square buttress of abdominal wall between vas and vessels, the buttress consisting of internal oblique and transversalis muscle with its fascia on the one side sutured to Poupart's ligament on the other (Figs. 5 and 7). None of the other methods of dealing with the cord take this weak point in the repair of a hernia into account, for they all treat the cord as a whole, and, in consequence, no matter whether the cord is allowed to come out at the lower part of the hernial opening (Ferguson), or is displaced according to Bassini to its upper part, the vas and the vessels still meet at an angle and invite a repetition of an obtrusion of the peritoneum between these structures which afford handsome smooth

gliding surfaces between which a hernia could again wedge its way out.

This method of closure at the internal ring deals effectively with oblique hernia. The remaining part of the plastic, the closure of that portion beneath the point where the vas deferens is brought out, has to deal with direct hernia, for the purpose either of repairing an existing direct hernia or of preventing the occurrence of one in a disposed individual. This part of the repair is of equal importance to that at the internal ring.

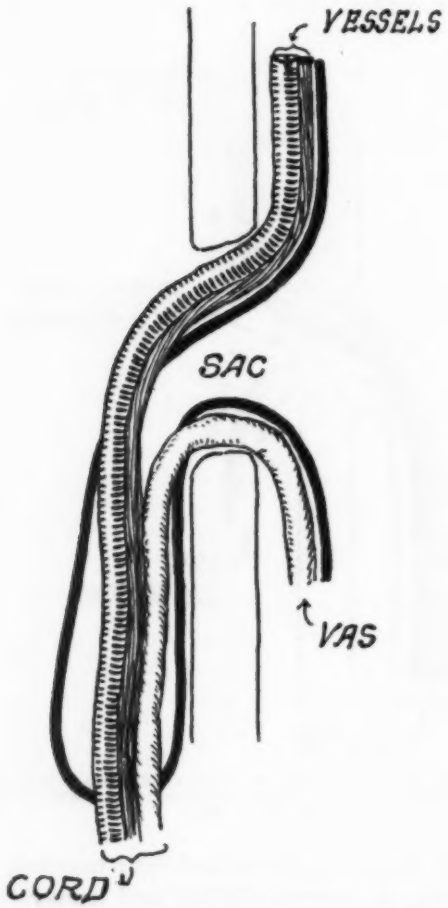

FIG. 4.—Diagram showing the relation of the sac to vas and vessels, the former being below, the latter above the sac. This relative position obtains only at the internal ring; farther down the relation becomes changed.

DESCRIPTION OF THE OPERATION

The skin incision, about four inches long, is made above Poupart's ligament, in the direction of the fibres of the external oblique aponeurosis, terminating mesially at the pubis, superficial to the external ring. Contrary to the recommendation of others who wish to avoid cutting the

superficial vessels at the lower inner end of this incision, and who therefore advise against carrying the incision quite so far down, I am in favor of making it amply large at the lower end. My reason for this is to be found in the great importance, at a subsequent step, of absolute accuracy in the insertion of the lowest one or two sutures that are to hold Poupart's ligament in neat and clean apposition with the rectus muscle or the conjoined tendon. With a free exposure better work can be done in that

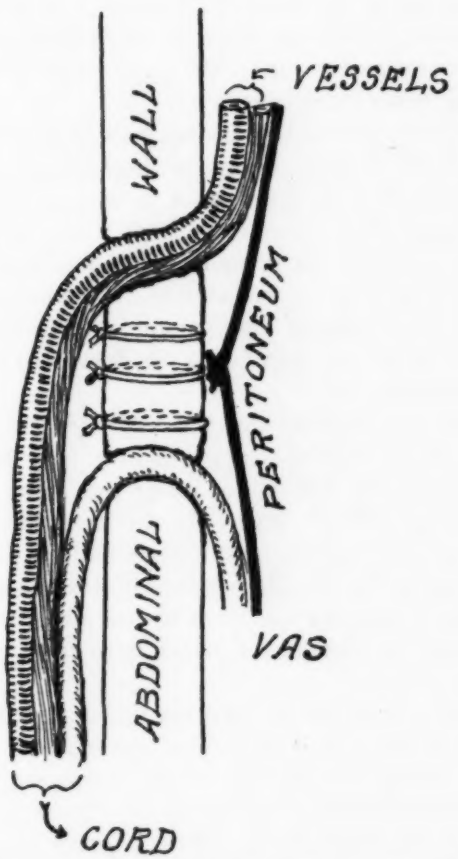

FIG. 5.—Diagram of the upper part of the plastic. Note that the vas deferens and the spermatic vessels are prevented from meeting at the internal inguinal ring by the interposition of sutures between them—sutures which connect Poupart's ligament with the muscles.

important step of the operation, and the additional trouble of dividing and ligating the superficial vessels which cross at the lower end of the incision is well repaid.

The external oblique aponeurosis is then incised in the course of its fibres, the incision terminating at the apex of the external inguinal ring. It is then reflected toward both sides, on the outer lower side so as to plainly expose Poupart's ligament all the way down to its insertion in

the pubis, on the inner upper side far enough backward to expose at least a three-quarters inch strip of the internal oblique muscle. The reflection of the aponeurosis here, as on the outer side, should extend all the way down to the pubis. This means that in the lower part the aponeurosis is separated from the rest of the anterior sheath of the rectus muscle. This procedure, though not essential, is nevertheless not quite unimportant, for the rectus muscle, after its release from the aponeurosis of the external oblique, becomes slightly more movable and can therefore more readily be approximated to Poupart's ligament at a later stage of the operation. The margins of the divided aponeurosis may now be held apart, if desired, by retractors or by the application of fine clamps to the cut edges, so as to expose the next layer.

The iliohypogastric nerve is seen coursing along the surface of the internal oblique muscle, often near enough to its free edge to be in danger of being included in the sutures later on to be laid connecting that muscle with Poupart's ligament. If the nerve is well out of the way, it is left undisturbed; otherwise it is dissected free from the muscle, so that it may be held aside when the sutures are inserted. This may be done by slinging it over the inner cut edge of the aponeurosis which in turn is grasped by a fine clamp. The clamp thus keeps the nerve out of the field during the rest of the operation.

The free border of the internal oblique and transversus muscles may now be more sharply outlined if this appears necessary in the given case. Sometimes it is very well defined, at other times the border is in part concealed by fat from a deeper layer. In the latter case a slight incision into the thin fascia which covers both muscle and fat, followed by a little blunt dissection under the muscle edge, liberates the latter and enables us, at a later stage, to procure that *clean* apposition of muscle to Poupart's ligament, without interposition of fat, which is so essential for a successful issue of the plastic.

The cord, together with the hernial sac which is bound up with it by connective tissue, is now lifted out of its bed. This requires tearing of some adipose and areolar tissue and often the ligation of a vessel. The separation of the cord from its bed should be carried well down, so that any attachment at the brim of the pelvis is done away with. This is desirable in order to enable us to attain, at a later stage, that clean apposition of Poupart't ligament to the muscles, without interposition of any other tissue, which has already been alluded to and which is of particular value in the management of the very important one or two sutures at the lower end of the plastic.

The separation of the cord into its elements is now in order. The cord may be slender or bulky, but its essential parts, the blood-vessels and the vas deferens, never take up much room. If it is bulky, the large size is accounted for by the mass of its cremaster muscle, sac, fat, or connective tissue. Everybody, of course, separates the sac, but even to some

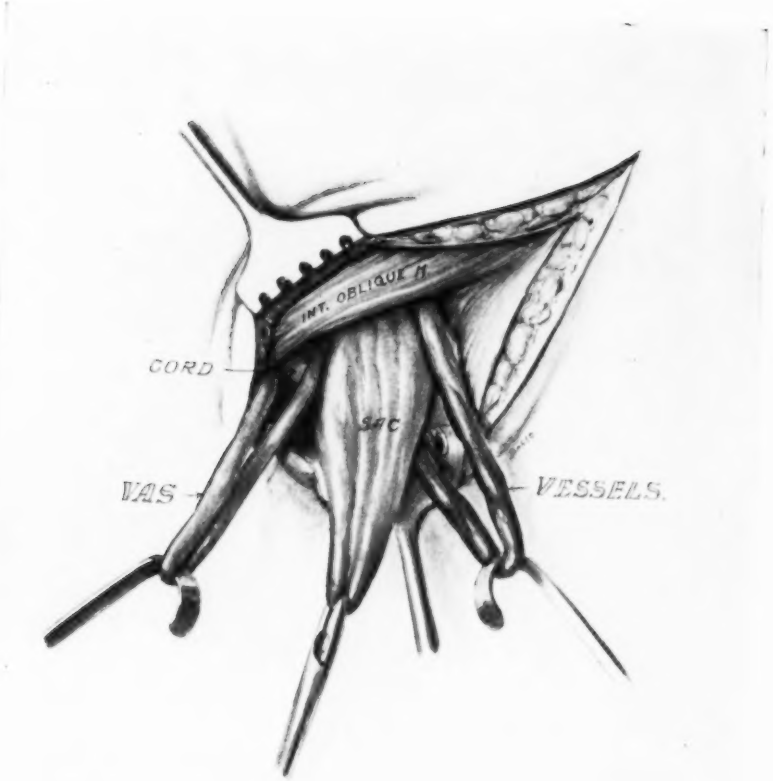

FIG. 6.—Left oblique inguinal hernia. The sac emerges between the spermatic vessels and the vas deferens.

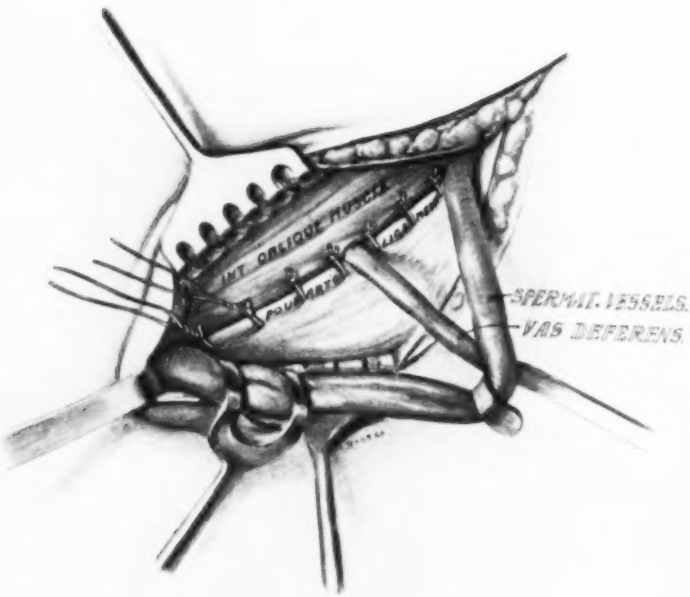

FIG. 7.—Left oblique inguinal hernia. Closure of the deep layer. The internal oblique and transversus muscles have been sutured to Poupart's ligament, three of the sutures separating the vas deferens from the vessels. The vessels emerge at the uppermost angle. The lower two sutures are silver wire, the others chromicized catgut.

of those who separate it high up, as should be done, the anatomical arrangement of the structures at the internal ring, which I have mentioned, may not be evident, if the connective tissue is not dissected off the vas and vessels; for the presence of that tissue will often mask the actual position of these structures. It is, however, desirable that the connective tissue be removed from vas, vessels, and sac, if one wishes to do justice to the principle of clean approximation of muscle to Poupart's ligament without interposition of other tissues. When the connective tissue has been dissected off, the relation of vessels, vas, and sac becomes evident, the vessels coming out above, the vas below, and the sac between them (Fig. 6).

My routine in dissecting the cord is to look first for the vas deferens, which will most frequently be found at the outer posterior part of the cord. This is separated from the rest of the mass and dissected all the way up to the internal ring. Then the vessels are similarly treated, and, when this has been accomplished, we know that we have the most important structures safely out of the way. Next the sac is liberated, and there remain only the cremaster muscle and considerable connective tissue, which latter is resected. In the course of this dissection we often find a good deal of fat, little lipomata, in the course of the sac or cord and extending into the abdomen. These collections of fat must be removed, their presence being highly objectionable; for, as they increase in size, they tend to drag the peritoneum out after them and thus create a condition making it likely for a new hernia to follow down. With the exception of vas and vessels no other structures should be permitted to be partly inside and partly outside the abdomen. They should be either wholly inside or wholly outside, but not within the ring. Here again the principle of clean approximation of the muscles to Poupart's ligament, without any interposition, holds good.

The sac is now emptied of its contents and tied off at the highest point possible. In my former publication I mentioned that in case of large herniæ a purse-string suture of silk is employed for closing the neck of the sac, the suture both beginning and ending on the peritoneal side, so that, when the knot is tied, it will lie on that surface. I wish to state here that I employ this method only in excessively large hernial necks; the vast majority are treated by transfixion and ligation, plain catgut being used for the purpose.

The treatment of the cremaster muscle next deserves consideration. The recommendation has been made to include the cremaster in the sutures connecting Poupart's ligament and the muscles "to give greater strength." I simply mention this proposition in order to condemn it. Far removed from the possibility of giving greater strength, the interposition of the cremaster would most decidedly tend to weaken the proposed union. For the purpose of a strong union we join one firm structure to another firm structure. These are, on the one side, the internal oblique

and transversus muscles and subjacent fascia, on the other side Poupart's ligament. The cremaster muscle, an offshoot from the internal oblique muscle, having no fixed point of attachment below, is, as far as strength is concerned, nothing more than a tail-like appendage the interposition of which between the above named structures would be just as objectionable as the interposition of fat or connective tissue and should under all circumstances be avoided. In many cases it is possible to lift the cremaster up out of the way and to suture the muscles to Poupart's ligament underneath it; at times, however, the muscle is so bulky and so fatty, and its origin from the internal oblique so diffuse as to make it difficult to handle. In such cases I do not hesitate to divide the cremaster at its origin or to resect it, after which a much neater, cleaner, and more satisfactory apposition can be made. I have divided many a cremaster and have never had a patient complain of symptoms ascribable to the loss of its function.

The closure of the deep layer is the next and most important step. The structures to be united are, on the outer lower side, Poupart's ligament, on the inner upper side the internal oblique and transversus muscles with the transversalis fascia and often the rectus muscles at the pubic end. This stretch naturally divides itself into two parts, an upper outer part corresponding to that opening in the transversalis fascia known as the internal inguinal ring, and a lower inner part where normally no opening exists. The upper part has to do with oblique hernia, the lower with direct hernia. Let us first consider the upper part. We have allowed the stump of the sac to slip back out of sight, we have removed all lipomata and other fatty tissue that found its way out through the internal ring, likewise all connective tissue, and we have held the cremaster aside or else have divided it, so that there is nothing emerging from the opening but the vas deferens and the vessels of the cord. We place the vessels into the uppermost angle and the vas into the lowermost angle of this opening. In the ordinary, fairly large hernia these two structures will then be at least an inch apart, giving space for three stitches half an inch apart (Fig. 7). In very large herniæ there will be room for more than three stitches between vas and vessels, while in very small herniæ the distance between vas and vessels may be only half an inch, giving space for only two stitches. There should never be less than two sutures between vas and vessels, for it seems that a single suture is hardly sufficient to overcome that infundibuliform meeting of vas and vessels which is so liable to promote a recurrence of the hernia. The sutures grasp, on the one hand, the internal oblique muscle, the transversus muscle, and if easily feasible the transversalis fascia; on the other hand, the full thickness of Poupart's ligament. As every little detail counts, attention is again called to the last of the above named four salient points, the observance of certain common sense rules. One of these, the avoidance of interposition of tissues between the approxi-

mated edges, has already been repeatedly alluded to. Another one, the demand for an absolutely accurate alignment of the approximated edges, seems self-evident, and yet I have had to call the attention of the majority of the men learning the operation to this point. For instance, after having carried the suture through the muscles, they would then gather Poupart's ligament at a point not directly opposite the one where the muscles were pierced, but perhaps half an inch higher up. In consequence, when the knot is tied, the relation of the two edges will not be natural but strained, the muscles being drawn up out of their proper place or the fascia at Poupart's ligament being split in the course of its fibres owing to the strain, and the result will be a weaker union than we should strive for and can attain by proper alignment. A third point is that the needle should be carried through Poupart's ligament gently, without force, so as to make a hole not bigger than the diameter of the needle; if brute force is employed and the fascia is torn instead of being simply punctured, the result is an impairment in the strength of the union. Those in whose hands the fascia tears have, as a rule, failed to consider that a curved needle, being an arc of a circle, should, in passing through the tissue, proceed in the circumference of the circle of which it forms an arc and not be pushed or pulled through in the direction of a straight line. In sewing skin or some other readily yielding structure this lack of proper technic may be pardonable, but it will never do in the case of a fairly fixed structure like Poupart's ligament. A fourth point is that a reasonable amount of muscle tissue should be grasped in the suture and the full thickness of Poupart's ligament as well. The adaptation of just a thin line of muscle to a thin line of fascia would hardly answer where we must build a wall capable to resist strain. A fifth point refers to the traction employed in tying the knot. What we wish to aim at is a good, firm, close approximation. Anything more than that may result in the suture cutting into or through the tissues intended for union, thus weakening the wall instead of strengthening it, while on the other hand, a suture tied too loosely may fail to bring the parts in proper apposition.

In this upper part of the plastic, the part corresponding to the internal ring, the highest suture is inserted directly under the vessels, which have been placed in the uppermost angle, and the lowest suture directly above the vas, which is in the lower angle (Fig. 7). The suggestion occasionally made of inserting a suture above the cord is not to be considered in this operation. The vessels having been placed in the uppermost angle, there is nothing above them to be sutured.

If we could be absolutely sure that our patient, whose oblique hernia we are repairing. were safe against the development of a direct hernia, the sutures between vessels and vas, just described, would suffice to meet the indication. However, this is not the case; on the contrary, we must consider him prone to develop hernia. The suture of the muscles to Poupart's ligament below the exit of the vas, and from there down to

the pubis, is therefore not only indicated but is imperative, even though an actual direct hernia may not exist.

The management of this lower portion of our hernioplasty is similar to that of the upper portion, just described, in so far as Poupart's ligament is sutured to the muscles opposite, but it differs in some details. First, there is no opening in the transversalis fascia to be closed. Secondly, the internal oblique and transversus muscles do not always run all the way down to the pubis but are more frequently inserted into the rectus fascia at varying distances from the pubis, so that at the lower end of Poupart's ligament we will usually find the rectus opposite to it and must unite it to that muscle. Thirdly, while in the upper section of our plastic there is scarcely ever any tension between the approximated tissues to amount to anything, at the lower part of the lower section tension between rectus muscle and Poupart's ligament is often present, except in women and children where these structures may not infrequently be brought together without much tension. To overcome this tension at the lower end several plans have been suggested, mainly the following two: First, turning over a flap of rectus fascia to be sutured to Poupart's ligament; secondly, incision of the rectus fascia and suture of the liberated rectus muscle to Poupart's ligament. There are objections to these methods, both of which I tried before my own method of operating was developed. The objection to the former is that a flap of rectus fascia, with its base at the outer edge of the muscle, has no hold on the mesial side, there being no posterior rectus sheath. If for any reason a similar flap were formed higher up on the rectus and fastened laterally, any pull on this flap, caused by a strain, would be transmitted through the posterior rectus sheath to the linea alba, thus affording real support to the abdominal wall; at the lower end of the rectus, however, the fascial flap so shaped could not gain a hold on the linea alba through the agency of the posterior rectus sheath, but would, under the influence of a strain, peel off laterally and add a very weak spot at the outer edge of the rectus without itself giving the desired strength at the place where it is sutured. If, on the other hand, a flap is made with its base higher up on the rectus, the insertion of the internal oblique and transversus muscles into the sheath loses in part its strong firm hold, and, in consequence, the upper part of our plastic is weakened. The objection to the other method, the employment of the rectus muscle without its fascia after splitting the latter, is this: If a short slit only is made, extending from the insertion of the internal oblique and transversus down to the pubis, the muscle cannot be sufficiently mobilized, and, if drawn out and attached to Poupart's ligament, will be under such tension that the sutures may easily cut through the muscle. If, on the other hand, the rectus fascia is incised upward far enough to facilitate the mobilization of the rectus, the fixed point to which the internal oblique and transversus muscles are attached, also becomes more movable and, in conse-

quence, those two muscles become slack, thus weakening the upper portion of the plastic of which those muscles play so important a part. I therefore do not open the fascia of the rectus, but draw over the muscle, with its fascia intact, to join it to Poupart's ligament, being satisfied with the slight degree of mobilization afforded by dissecting the external oblique fascia from the remainder of the rectus fascia, as explained above in the paragraph on the management of the external oblique aponeurosis.

The sutures are inserted at three-eighths to one-half inch apart, according to the amount of tension; greater tension requires closer suturing. No gaping of tissues between sutures should be permitted. The lowest suture should be quite close to the pubis. As regards suture material I employ silver, usually No. 26 or slightly heavier for the lowest one or two sutures, the ones where the tissues have to be approximated under tension; for the remaining sutures I use chromicized catgut, usually No. 3. The tension is greatest either at the lowest suture or at the one just above the lowest. In my former publication I stated that I employed silver wire throughout, though I did not wish to be dogmatic as to the selection of the suture material. At present, I have given up the use of silver wire for the majority of the sutures, but I do wish to be emphatic on one point, the use of non-absorbable suture material wherever the approximation is under tension—and that means at the lowest one or two sutures, where the rectus and Poupart's ligament are united. Every surgeon is aware that even the most securely tied catgut knots may open when the suture material imbibes fluid, especially when under tension. But no one knows exactly how long it will take, in a given case, for plastic material to be shed out by such tissues as the rectus sheath and Poupart's ligament in sufficient amount to unite them, nor how long it will take that plastic material to become so strong that it will definitely hold the said structures firmly together. We may, however, be quite sure that such structures as those mentioned are among the slowest to shed out plastic material. The presence of foreign material, on the other hand, encourages the formation of a plastic exudate, as I had occasion to see at an autopsy, described in my former publication, on a case of death from appendicitis in a patient who had been operated upon by me about three months before for hernia. I hold, therefore, that we are taking an unnecessary risk if we employ absorbable material for these particular sutures. Silk or Pagenstecher thread will answer the purpose very well, and in my earliest work I employed silk, but soon changed in favor of silver which appealed to me owing to its slight antiseptic value and the smoothness of its surface. All sutures are inserted before any are tied. We start with the closure of the silver sutures.

The management of silver wire may require a little practice. Silver wire does not lend itself to correction of the degree of tightness of adaptation after it has been twisted. The proper amount of pull must be

estimated and carried out at the first turn given the wire to fix it. Secondly, that first turn should be a complete turn, a half turn not being sufficient to hold the parts together when the suture is under tension. A little experimentation will soon teach anyone how this is accomplished by crossing the two ends of the wire and crossing the hands before tightening up and giving the necessary twist. Then two or three supplementary twists are added. Those who prefor to employ a tool for this purpose will find appropriate wire twisting instruments in the market. Thirdly, the twist in the wire should be placed directly over the suture hole in the muscle, not over Poupart's ligament. The wire is cut off so as to leave an end about one-eighth to three-sixteenths of an inch long. This is turned by the aid of a forceps toward the midline of the body, so as to lie on the muscle; then its distal end is bent a second time so as to embed the point in the muscle, thus putting it where it cannot possibly injure the cord (Fig. 8).

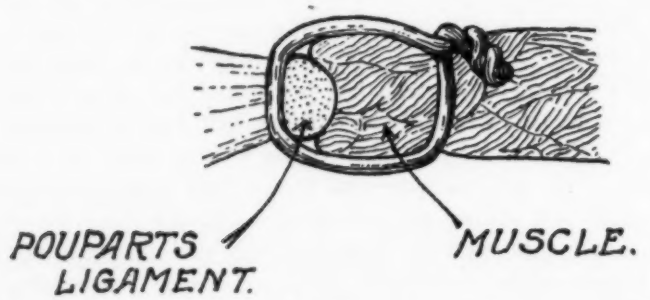

FIG. 8.—Schematic representation of the method of embedding the cut end of the silver wire into the muscle.

There exists, in the minds of some, a sentimental objection against the introduction of non-absorbable material for buried sutures, but there is no doubt that this material, whether it is silk or linen thread or silver wire, has a definite place in surgical technic. The introduction of these little particles of silver wire must not be likened to the use of a silver filigree to which there is a very valid objection. If a silver net is placed in the inguinal region and is subjected thousands of times to a process of bending and straightening out again, as it must be in so movable a part of the body, it is very likely to break. When the use of silver filigree was more fashionable than it is now, I had to remove a number of those appliances because they were broken and the sharp ends caused one or other kind of damage. Not so with the small piece of silver wire used in the individual suture, if the point is properly buried; it will adapt itself to all changes of position of the body. I have recently had the opportunity of operating for femoral hernia in a case where I had operated for inguinal hernia eight years before. Not wishing to disturb the field of my former operation I refrained from doing the Lotheissen operation, which otherwise would have been my choice, but attacked it from underneath

Poupart's ligament and was able to see the small size of my silver sutures as well as the firm hold they had maintained. In that case I had used silver wire sutures throughout for uniting Poupart's ligament and the muscles, as was my custom then; and even lately, in a few cases of very large hernias, where there was tension not only below but also in the upper part of the plastic, I have employed silver wire for all the sutures.

There are still two layers to be sutured, *the aponeurosis of the external oblique and the skin.* But as far as the cure of the hernia is concerned our work is complete when this first, deep layer has been properly attended to. If the deep layer should fail to hold, the aponeurosis of the external oblique will not be able to make good the deficiency, even if it is doubled by the method of overlapping. The external oblique, nevertheless, is sutured, for in the first place it furnishes a neat covering for the cord, and in the next place it supplies a barrier against an eventual stitch infection being carried down to the depth before it is noticed. I must admit that I occasionally experience a stitch infection. A paper that impressed me very much was one by Doctor Brewer in which he reported six months' active hospital work without an infection. I have gone a little less than half that length of time without stitch abscesses, but off and on they still occur.

In conformance with my view as to the slight value of the external oblique in giving strength to the plastic I refrain from doubling it up. The edges are simply brought together by a continuous plain catgut suture, not forgetting to replace the iliohypogastric nerve, if it had been hung over the mesial edge of the fascia. For the same reason I had, until a year ago, made no special effort to carry the suture of the external oblique well down to the pubis. Then I had the experience that a physician brought a patient to me on whom I had operated, claiming that the patient had a recurrence, inasmuch as he could insert his finger into the external ring. I explained my method to him, stating that no effort was made to close the external oblique well down. Then he said he thought there was an impulse on coughing; but I was able to demonstrate to him that the impulse he felt was the handsomest, firmest muscular contraction one could wish for. Since that time I have thought it wiser to close the external oblique well down to avoid disturbing the peace of mind of any patient in whom an open external ring might be discovered.

Speaking of supposed recurrences I might mention another experience. The family physician of a patient on whom I had operated told me he had received word from the patient that he had a recurrence. I requested to have him sent to me for examination. This, however, was delayed and delayed, and when I made the matter more urgent and offered to visit the patient, he could not be found. So I entered him as a case of recurrence, on the strength of the patient's own report. Then,

after about two years' disappointment over the case, the patient had to present himself for military draft, and before doing so, came to my office for examination. It was evident that what the patient had called a recurrence was the development of a hernia on the other side, the operated side being in perfect condition.

The suture of the skin completes the operation. A very small dressing, held by adhesive plaster, is applied. In cases of children and meddlesome patients the application of a spica would be indicated. The patient is kept in bed for two weeks; in exceptional cases a few days longer.

In 17 cases the appendix was also removed by combined operation,[1] and in 6 cases the undescended testicle was brought down at the same time according to the method of orcheopexy I described.[2]

A separate description of the *operation for direct inguinal hernia* is unnecessary. In speaking of the closure of the deep layer I mentioned that the operative field divides itself into two portions, of which the upper outer, corresponding to the internal inguinal ring, is concerned with the operation for oblique hernia, while the lower inner portion has to do with direct hernia. In cases of direct hernia, therefore, we simply omit the first part of the operation. If the direct hernia manifests itself in the shape of a well defined sac, we resect it, remembering, however, that the protruding part may be the bladder. If there is merely a bulging of the transversalis fascia, we may reef it or leave it entirely undisturbed, simply inserting our sutures in the manner described. A warning of considerable importance, however, must be given. It is absolutely necessary that we ascertain whether we have to deal solely with a direct hernia or with a combination of direct and indirect. In cases of direct hernia we very often find an oblique hernia associated with it. At times the presence of such oblique hernia is quite evident, at other times a small sac is hidden in the upper part of the cord. An anatomical dissection of the vas and vessels, as for oblique hernia, will clear up the situation and should be practiced. The neglect of a small sac at the internal ring would be likely to cause a recurrence in the shape of an oblique hernia, no matter how well the direct hernia had been repaired.

SUMMARY

1. Skin incision about four inches long above Poupart's ligament in the direction of the fibres of the external oblique muscle down to the pubis at the external ring.

2. Incision of the external oblique in the course of its fibres, terminating in the external ring where it also divides the intercolumnar fascia.

3. Reflect the outer margin of the external oblique so as to expose Poupart's ligament all the way down to its insertion in the pubis. Like-

[1] Torek: Combined Operation for the Removal of the Appendix and the Cure of Right Inguinal Hernia. ANNALS OF SURGERY, May, 1906.

[2] Torek: The Technique of Orcheopexy. N. Y. Med. Journ., Nov. 13, 1909.

wise reflect the inner margin of the external oblique all the way down to the pubis, at the lower end separating it from the rest of the rectus sheath.

4. The border of the internal oblique and transversus muscles is freed of connective tissue and fat.

5. Lift the cord out of its bed, liberating it on all sides and entirely loosening its attachments at the brim of the pelvis.

6. Dissect the vas deferens, spermatic vessels, and sac clean of connective tissue well up to the internal ring, until the sac is seen to emerge between the vessels and the vas, the vessels being above the sac, the vas below.

7. Remove all lipomata and other fatty tissue, as well as the connective tissue, from the region of the internal ring, allowing no structure, except vas and vessels, to be partly inside, partly outside the abdomen.

8. Empty the sac, transfix it at the highest point possible, tie, and cut off.

9. Lift the cremaster well out of the way before suturing; do not include it in the suture. If it is unmanageable on account of its bulk or because of a diffuse attachment to the internal oblique muscle, divide it or resect it.

10. Before introducing the sutures, the spermatic vessels are placed in the uppermost angle and the vas deferens in the lowermost angle of the internal ring, these structures being kept apart by the sutures which unite the internal oblique and transversus muscles and transversalis fascia to Poupart's ligament between them. In the average fairly large hernia there is room for three sutures between the vessels and the vas; in very large ones more than three stitches are inserted in this section of the plastic; in no case less than two. These sutures, of which the highest is placed directly under the vessels, close the oblique hernia; below the point of exit of the vas additional sutures, extending all the way down to the pubis, are inserted for the cure of a direct hernia or the prevention of its occurrence. At the lower end of this section, the direct hernia section of the plastic, there is often no internal oblique or transversus muscle available, owing to their insertion in the rectus fascia higher up. In that case the rectus, with unopened sheath, is attached to Poupart's ligament.

11. The sutures are introduced three-eighths to one-half inch apart, greater tension requiring closer suturing, so as to allow no gap to exist between sutures. In suturing observe the following points: The apposition of muscles to Poupart's ligament must be clean, without interposition of connective tissue or fat or cremaster muscle. The alignment must be absolutely accurate, *i.e.*, after the needle has penetrated the muscles, it should catch Poupart's ligament at a point directly opposite, not half an inch higher or lower, as otherwise one or other tissue will tear. Carry the needle through Poupart's ligament gently, so as to make a hole no

bigger than the diameter of the needle. Follow the curve of your needle in going through Poupart's ligament; do not pull it through in a straight line, or else you may split the fascia and weaken your plastic. Grasp a reasonable amount of muscle and the full thickness of Poupart's ligament in your suture. In tying the knot aim at a good firm approximation, no more, no less; a looser suture may leave a gap, while too tight a suture will cut the united tissues, in either case weakening the union.

12. The suture material for the lowest one or two sutures, where the rectus is approximated to Poupart's ligament under some tension, is silver wire, usually No. 26, or some other non-absorbable material; for all remaining sutures chromicized catgut, usually No. 3. All sutures along the whole line are introduced before any are tied. Begin by closing the silver sutures, observing the following: Twist the wire directly over the suture hole in the muscle, not over Poupart's ligament. Estimate the proper amount of pull necessary for good approximation so as to get it right when the first twist is made; an attempt at subsequent correction may break the wire. A complete turn is necessary to hold the parts together when there is tension, therefore hold your hands in such position that a complete turn can be made. Add two or three more twists, cut off so as to leave an end about one-eighth to three-sixteenths inch long, turn this end with a forceps toward the midline, so as to lie on the muscle, give its distal end a second turn so as to embed the point in the muscle.

13. The cure of the hernia depends upon the perfect union of this deep layer and on it alone. The suture of the next layer, the external oblique, serves as a covering over the cord and is done in the simplest manner, without overlapping, using plain catgut. The skin is then sutured. The patient remains in bed two weeks; exceptionally longer.

14. In cases of direct hernia the vas and vessels are found not to be separated at the internal ring; the sutures between vas and vessels are therefore omitted. Otherwise the operative procedure is the same. But make sure that there is not an oblique hernia present besides the direct hernia.

THE TRANSPLANTATION OF THE RECTUS MUSCLE OR ITS SHEATH FOR THE CURE OF INGUINAL HERNIA WHEN THE CONJOINED TENDON IS OBLITERATED. THE TRANSPLANTATION OF THE SARTORIUS MUSCLE FOR THE CURE OF RECURRENT HERNIA WHEN POUPART'S LIGAMENT HAS BEEN DESTROYED*

By Joseph Colt Bloodgood, M.D.
of Baltimore

All surgeons admit a small per cent. of recurrences after operations for the cure of inguinal hernia even when the wound has healed by first intention.

After my study of the results of the operations performed at Johns Hopkins Hospital up until 1899 I felt convinced that the chief cause of recurrence in the lower angle of the wound was due to the fact that, whether the hernia was direct or indirect—the conjoined tendon was either weak or obliterated, and that the ordinary suture or closure of the defect in the abdominal wall was not sufficiently strong to protect from recurrence in the lower angle.

Reports on the ultimate cure of inguinal hernia previous to those of Halsted and Bassini were complicated by the suppuration of the wound. This factor undoubtedly was the chief cause of recurrence; for this reason lesser factors were not discovered.

Practically all surgeons who have contributed to the operative problem of curing an inguinal hernia recognize the importance of the conjoined tendon. From their description it is clearly evident that the conjoined tendon was caught in the lower sutures; the internal oblique muscle was sutured to Poupart's ligament; an effort was made to reduce the size of the external ring and make a snug external ring about the cord.

It is quite possible that the failure to cure depended more on the suppuration of the wound than any fault in the suture. McEwen apparently obtained the best results. In every case after his operations the wound was drained. This procedure may have limited infection. The results, however, must have been discouraging, because McBurney in this country left the wound open to heal by granulation. As far as I am able to ascertain, the results of this method were no improvement over the former methods. It is also quite possible that the brilliant results of Halsted and Bassini may have been due to the improvement in wound technic at that time and perhaps to the more perfect asepsis of their respective clinics, and not to the transplantation of the cord.

When I studied the results in Halsted's clinic I also found that when the wounds suppurated, which was not infrequent in the early years of

* Read by title before the American Surgical Association, June, 1919.

the clinic, recurrence of the hernia was observed in from 25 to 30 per cent. of the cases. However, when the wound healed *per primam,* recurrence was reduced to less than 6 per cent. These recurrences were of two distinct types: One, in the upper angle of the wound, at the position of the transplanted cord, *when the veins were not excised,* usually a small affair, giving very little discomfort and rarely leading to second operation. In the second type the recurrence was in the lower angle of the wound, and my investigations at that time showed that this recurrence had no relation to the position of the cord. It was observed when the cord was and when it was not transplanted, or when the cord was excised or castration performed in older patients.

Fortunately, our excellent notes made before and during the operation on the condition of the conjoined tendon allowed me to conclude that the factor which led to the recurrence was the obliteration of the conjoined tendon at the time of the operation. I have observed both these types of recurrence in patients who have been operated on by the Bassini method, but as my experience with this method is limited entirely to recurrent hernias, I am unable, of course, to obtain any figures as to the exact percentages.

Unfortunately, when Halsted published his first contribution on the cure of inguinal hernia the illustrations and text emphasized the importance of the transplantation of the cord. Nevertheless, in my opinion, this was a minor part of the technic. In one of Halsted's publications he emphasized the importance of closing the defect in the inguinal canal as one would close the wound after any laparotomy—by a most careful suture of all the available fasciæ and muscles without tension with interrupted silk. In Halsted's operation, after the division of the aponeurosis of the external oblique, the division of the covering of the sac, the complete excision of the sac and the closure of the peritoneal cavity high up, the internal oblique muscle was mobilized, so that the conjoined tendon and this muscle could be sutured to Poupart's ligament snugly without tension. During this period surgeons who operated had in mind apparently the transplantation of the cord, and many chose Bassini's method, because it appeared simpler and was less of an operation than Halsted's in which the internal oblique muscle was divided to allow a higher transplantation of the cord. But as far as I can gather, the chief features of Halsted's and Bassini's operation for the cure of inguinal hernia, were the painstaking closure and good healing of the wound.

The objection we found to silk for suture was the increased per cent. of suppurations or stitch abscesses. This led Halsted to change to silver wire which was followed by a better per cent. of healing. Suppuration of the wound, however, was not practically eliminated until gloves were worn at the operation, then it was found that we could return to the employment of silk as a buried-suture material. Due to the great im-

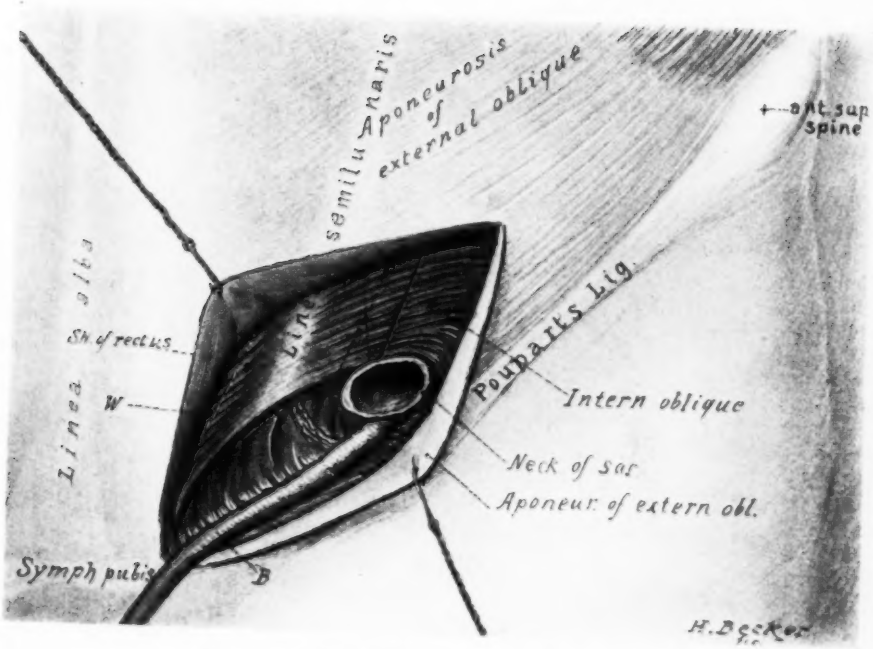

FIG. 1.—Illustrates the anatomy of the inguinal canal.

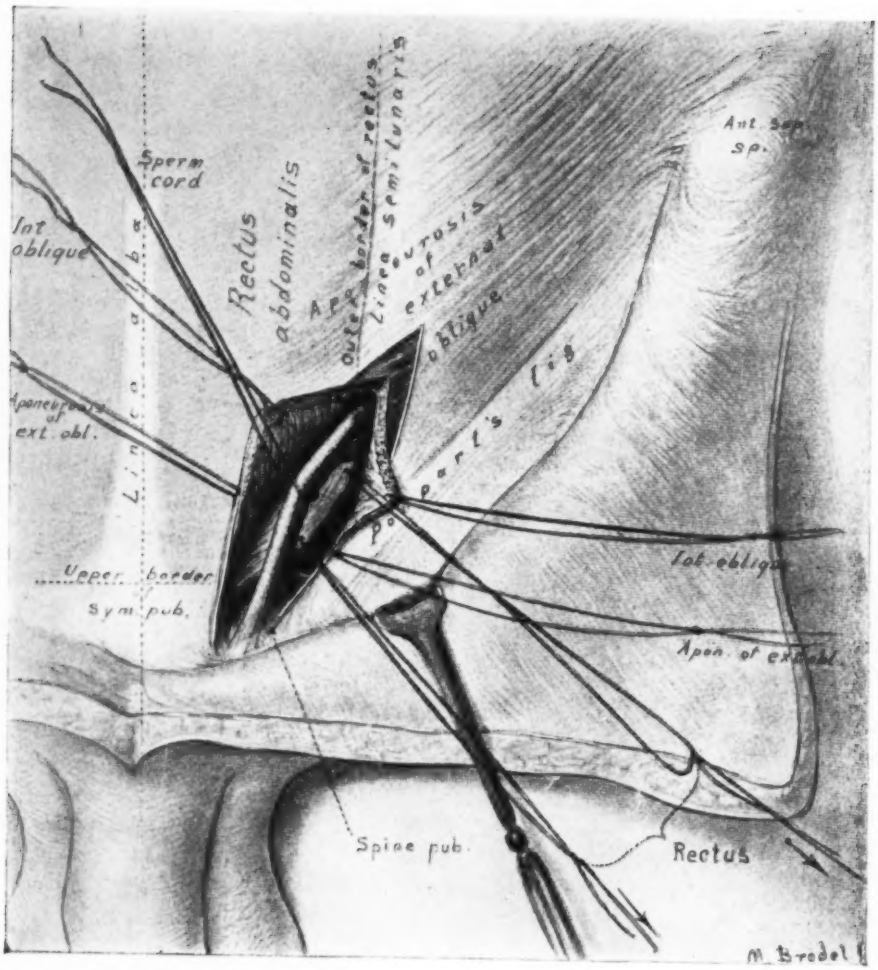

FIG. 2.—My original method of transplanting the rectus with transplantation of the cord—a method from which I got better results than later when the cord was not transplanted.

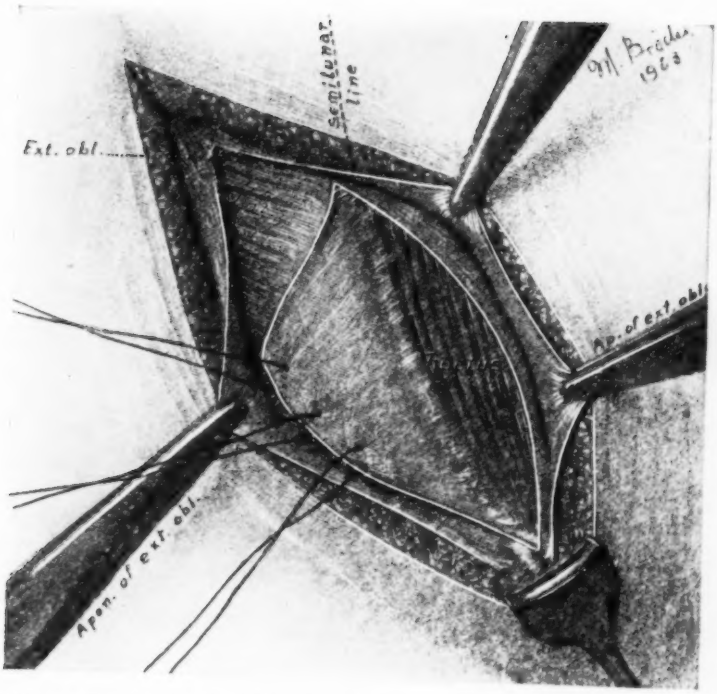

FIG. 3.—Halsted's modification of transplantation of the rectus sheath without transplantation of the cord.

provement in the preparation of chromicized catgut I am now using this suture material in place of silk.

Obliteration of Conjoined Tendon.—My first publication was in 1898 (*Johns Hopkins Hospital Bulletin,* 1898, ix, No. 86), the second in 1899,[1] and not again until 1918.[2]

During this period I paid much less attention to hernia and operated chiefly on recurrent cases, and my chief interest was centred on that small group of herniæ in which the conjoined tendon was obliterated and which I attempted to cure by the transplantation of the rectus or its fascia (Halsted's modification). A careful following of this small group demonstrated that there was a certain per cent. of recurrences and that the transplantation of the rectus muscle and its fascia was not a certain cure.

During the recent war I had an opportunity to examine in Maryland a large number of selected service men who were placed in Group B because of inguinal hernia. It was very interesting to me to find that the per cent. in which the conjoined tendon was obliterated was about the same as I had found in 1899—5 per cent. As the majority of these selective service men volunteered to be cured of their defect in order to render service, I had an opportunity in a few months to operate on more than one hundred cases.

As I had had recurrences I felt that some modification must be made to the previous method. In this type of hernia, when one invaginates the scrotum and introduces the finger into the external ring, little or no resistance is met and the finger passes over the pubic bone, and, as a rule, can be pushed into the space of Retzius behind the rectus muscle. When this anatomical defect is present on both sides the two fingers meet behind the recti.

The weakness in the abdominal wall is therefore bounded laterally by Poupart's ligament and the rectus muscle, and below by the pubic bone. The firm and perfect closure of this opening is hampered by the presence of the cord.

When I first transplanted the rectus in order to suture it to Poupart's ligament and thus strengthen the defect in the lower angle of the wound due to the obliteration of the conjoined tendon, I also transplanted the cord and excised the veins as in the Halsted operation (Fig. 2).

Since my publication in 1899 we discontinued to transplant the cord and rarely excised the veins, and when this rarer type of inguinal hernia presented itself, we continued the method of transplantation of the rectus, usually with Halsted's modification of transplanting its sheath (Fig. 3), but we did not transplant the cord.

As far as I am able to ascertain, in the group in which I had trans-

[1] Johns Hopkins Hospital Reports, vol. vii, 1899, p. 273.

[2] Jour. Amer. Med. Ass., Feb. 25, 1918, lxx, 515.

planted the cord (Fig. 2) there has been only one recurrence, but since the change in technic of leaving the cord undisturbed in the lower angle of the wound I know of at least four recurrences in operations which I performed myself, and it seems strange that this made no impression.

The last operation performed by me of this later technic was May 20, 1918. But shortly after this operation a patient on whom I had operated March 16, 1918, suffered a recurrence. This patient had a double direct inguinal hernia; both conjoined tendons were obliterated. The herniæ were of the type of small reducible bubonoceles. In this case both recti and their sheaths were transplanted, but the cord was left undisturbed. It was this recurrence that led me to return to the first method of transplantation of the cord, all but one by the Bassini method. It is too early to judge of the result. All of these patients are in service and have not yet returned.

Report of Case.—In the following case I transplanted the rectus muscle and its sheath without transplanting the cord on May 20, 1918. The conjoined tendon was obliterated. The wound healed *per primam,* the patient entered the army as an officer of the Quartermaster Corps. He was discharged from the army in December, 1918, and in February 20, 1919—ten months after operation—there was a definite recurrence in the lower angle of the wound. For about two weeks before the appearance of bulging there was definite local pain in the region of the external ring.

Anatomical Findings at the First Operation.—The hernia was of the type of a small bubonocele. The patient was a white male, aged thirty-three, of good muscular development, a little over weight, and of sedentary habits. One could pass the index finger through a large and relaxed external ring directly over the pubic bone into the space of Retzius. The hernia had been observed eight months. No truss had been worn.

There was no hernia or weakness on the left side.

At the operation the external ring was found to be large and split, corresponding to the findings before operation. Above the cord there was a bulging between the internal oblique above, the edge of the rectus to the medial side, and the pubic bone below. This bulging was to the medial side of the deep epigastric vessel. The bulging was covered with fat. It could be easily seen and felt when the patient coughed or strained, as the operation was being performed under local anæsthesia. There was no distinct sac. A triangular flap of the rectus sheath was turned down (Fig. 3), the internal oblique and rectus muscles were mobilized, and all of this tissue was sutured to Poupart's ligament by two rows of chromicized catgut. Then Poupart's was overlapped and sutured to the rectus sheath and internal oblique. Then the aponeurosis of the external oblique was folded over this line of suture and fixed to Poupart's. This is the usual method of imbricated suture.

In this case we had a small bulging of the type of a direct hernia. There was no evidence whatever of the conjoined tendon. From my observation this is the most difficult type of hernia to cure. When the bulging is small, the surrounding fascia and muscle have not been stretched and not thickened by inflammatory reaction, and although we attempt the so-called imbricated suture, we are not able to get much of an overlap, because the tissues have not been sufficiently stretched.

It is in this type that I have had recurrences before in spite of a most painstaking suture and making the ring as snug as possible about the untransplanted cord.

Anatomical Findings at Second Operation.—The recurrence was observed ten months after the first operation, and the second operation was performed two months later. The examination before this second operation was almost identical with that before the first. The finger invaginating the scrotum and following the cord passed over the pubic bone into the space of Retzius, but the tissues about the external ring were much thicker than before the first operation. The recurrent bulging and opening were above and to the medial side of the cord and admitted two fingers.

At the operation the wound having healed so perfectly, we could recognize and separate the anatomical structures just as clearly as in the primary operation. The recurrence was not due to any split in Poupart's ligament on the lower side, or any split in the rectus sheath or muscle on the medial side, but was a definite opening below the line of suture along the cord. At this second operation I transplanted the cord as in Halsted's method. That is, it lay between the subcutaneous fat and the aponeurosis of the external oblique. But I did not split the internal oblique muscle (Fig. 2). This was done, because the aponeurosis of the external oblique was somewhat thickened, and I felt that in view of the scar tissue the cord would be subjected to less pressure and would interfere less with the suture of the lower angle of the wound if I brought it out from the upper angle.

The results of the previous operation had produced thicker and stronger fasciæ and in the imbricated suture I was able to get a wider overlap. The sac in this case was not opened, but somewhat isolated and reduced. In my experience in small direct herniæ not much is gained by opening the sac, and when one pulls it out for high ligation there is some risk of injury to the bladder. I have no evidence to suggest that failure to open, partially excise and close a sac of this kind has anything to do with recurrence.

At this writing, about two and one-half months after operation, the patient is at work and apparently well.

Subsequent to the first operation upon this patient in May, 1918, I have always transplanted the cord when the rectus muscle and sheath had been transplanted, because of the obliteration of the conjoined tendon, and have usually followed the Bassini method of transplanting the cord.

CONCLUSIONS

I have been induced to present this paper before the American Surgical Association, not because the problem of the cure of this type of inguinal hernia is settled, but because of the apparent indifference of the majority of operators to make any change in the technic of their usual procedure, when there is every evidence that the chief weakness is in the lower angle of the inguinal canal due to the obliteration of the conjoined tendon, and not in the usual position, in the upper angle where the cord is situated, and through which the testicle descended.

I have read most of the contributions by surgeons operating in our various training camps for the cure of hernia in soldiers, and thus far I have failed to find a single mention of any change in the technic or to the conjoined tendon, or the transplantation of the rectus or its sheath.

I am confident that this anatomical defect is largely responsible for our recurrences, although these may be relatively few. Some definite change in technic must be made before the number of such recurrences is materially reduced.

There should now be an unusual opportunity, because thousands of men in the selective service and soldiers have been subjected to the operation for the cure of inguinal hernia.

The Transplantation of the Sartorius Muscle for the Cure of Inguinal Hernia When Poupart's Ligament Has Been Destroyed.—I observed some years ago that to completely excise the glands in the groin for primary or metastatic malignant disease, it was usually essential to completely excise that portion of Poupart's ligament corresponding to the inguinal canal.

In three cases of extensive cancer of the penis with metastasis to the glands of both groins, I removed by *en-bloc* dissection the penis, both testicles and cord, Poupart's ligament, everything in the inguinal canal and Scarpa's triangle. To fill the defect left by the removal of Poupart's ligament I divided the sartorius in the middle of the thigh, isolated it except at its upper attachment, placed it over the inguinal canal and sutured it in place.

One of these three patients is living more than five years since operation. There is no hernia on the right side; there is a small bulging and opening on the left side, which gives the patient no discomfort. This case appears to be a pretty good test of the value of this muscle transplantation.

More recently, in two cases of malignant pigmented mole of the leg with metastasis to the glands in one groin I performed the identical operation, except that the cord was not excised, but at least one-half of Poupart's ligament was excised from the pubic bone. One of these patients—an officer in the army—returned to full duty in the infantry. There is no weakness in the scar and no interference with the function of the limb. The result in the second case is equally good.

It has recently occurred to me that this muscle could be utilized in some rare cases of recurrent inguinal hernia in which Poupart's ligament has become practically obliterated by previous operation, but I have had no opportunity to carry out this idea since it occurred to me.

Note on the Transplantation of the Cord.—In the great majority of inguinal herniæ where the conjoined tendon is wide and firm and where the internal oblique muscle is well developed and can be mobilized, there seems no difficulty in making a suture without disturbing the cord, or ligating the veins, and the careful study of the results in these cases demonstrates the correctness of this statement.

I feel confident, as already brought out in this paper, that when the weakness in the inguinal canal is in the lower angle due to the obliteration of the conjoined tendon, a proper suture for a permanent cure can only be done by separating the cord from its attachment and transplanting it either by the Bassini or Halsted method.

There will also be a few other cases in which it would seem safer to transplant the cord. In this group the conjoined tendon will be wide and firm, but the internal oblique muscle will be found to be attenuated and very difficult to mobilize.

I have just operated on such a case. The patient had been operated on for appendicitis and drained some twenty-six years ago. One year later a second operation was performed for hernia in the scar. About one year after this second operation a right inguinal hernia developed which finally became scrotal and during the past year difficult to reduce.

Operative Pathology.—The patient was stout, the subcutaneous fat thick and adherent to the aponeurosis of the external oblique. The external ring was not very large, nor was the aponeurosis of the external oblique relaxed. The sac contained omentum adherent to the fundus of the sac. The omentum was ligated and reduced through an opening which hardly admitted two fingers. The remainder of the sac and omentum was removed. The cord in the inguinal canal was larger in diameter than a man's thumb. The internal oblique muscle was attenuated, largely replaced by scar tissue and practically immovable. The conjoined tendon was wide and firm. Poupart's ligament was thickened by scar tissue. This cord was unusually large, and in my experience would act as a factor in recurrence in either the upper or lower angle of the wound. The size of the cord was reduced by isolating, ligating and excising all but the vas and a few accompanying vessels. This mass was composed of numerous thick-walled veins and scar tissue, much larger than the usual variocele. To excise this mass of veins it was necessary to isolate the entire cord, so that the vas with its remaining vessels could either be left in the lower angle of the wound or transplanted. I found that I could make a better suture of the lower portion of the wound by transplanting the vas, which I did according

to Halsted's method, as the aponeurosis of the external oblique was too attenuated to allow a good covering by the Bassini method.

It is of interest and importance to note here that when I reported on the results in the Halsted clinic in 1899, we were unable to find a single recurrence in the group in which the cord had been transplanted and reduced in size by the excision of the veins, and in which the conjoined tendon was wide and firm. The only objections to this method were a very few cases of atrophy of the testicle and hydrocele. But in my contribution I demonstrated that atrophy of the testicle depended upon hemorrhage from the lower stump of ligated veins, and with good technic the veins could be excised without any danger of atrophy of the testicle. But there is always the possibility of a hydrocele.

There should be no question in the mind of the surgeon or the patient that it is better to run the risk of a hydrocele than of a recurrence of the hernia, and I am confident from my experience that in some cases of inguinal hernia the cord should be reduced in size by a most careful ligation and excision of the veins, and in a small group the lower portion of the wound can be closed better by the transplantation of the cord. So far as I am able to observe, it makes very little difference whether this is done by the Bassini or by the Halsted method.

STRANGULATED AND IRREDUCIBLE HERNIÆ

By Edward H. Risley, M.D.
of Boston, Mass.

The purpose of this paper is to call attention to and to discuss several forms of operative technic, varying from the normal, which have proved to be of life-saving value in the treatment of the acute emergencies produced by the strangulation of various herniæ.

In any discussion of the subject the question of the choice of anæsthetic is an important one, and, while, in the minds of experienced operators, there does not seem to be much doubt but that local anæsthesia is the anæsthetic of choice, yet it is believed that individual cases admit of considerable variation in regard to the use of local or general anæsthesia.

It is recognized, of course, that for the patient with a strangulation of over six to eight hours' duration, in whom there is vomiting, distention, and unsatisfactory pulse, local anæsthesia would be ideal, and in practically all strangulated herniæ which are not large and which have not been previously encarcerated or traumatized by attempts at taxis, this is so.

But a differentiation must be made, for there are many herniæ previously encarcerated, or of long standing, or which have been subject to trauma, in which there are so many adhesions or œdema present that the separation both of the sac from the surrounding tissues and of the adhesions inside the sac is extremely difficult and painful under local anæsthesia, so that the effort to separate such adhesions may result in more shock to the patient than if the operation had been more quickly done under a skilfully given light ether anæsthesia.

It is rare that this type of case is suitable for gas-oxygen anæsthesia, both because the patient is probably in a more or less starved condition and also because of the probable operative difficulties under this anæsthesia.

In the simple case of short duration and with a fairly small hernial sac, local anæsthesia is ideal, but in this type of case, on the other hand, there is generally no contraindication to ether, and some patients much prefer it. It is, therefore, customary when there has been no contraindication to give the patient his own choice of anæsthetic in this type of case. Results have been uniformly good whether a local or general anæsthetic was used.

The preference, however, is for local anæsthesia, as it is also in practically all simple uncomplicated cases of hernia.

The anæsthetic, whether local or general, has always been preceded by the appropriate dosage of morphia alone, if local is used, and morphia and atropin if a general anæsthetic is used.

Local preparation of the operative field has been with full strength iodine, preceded by benzin and followed by cleansing with alcohol. Thus

all possibility of skin irritation from too long contact of the iodine or of possible irritation of the intestinal coats, should they accidentally come in contact with the skin surface, is avoided.

When fecal vomiting has occurred, the stomach is always washed out before the patient is given a general anæsthetic, and after operation and before the patient leaves the table in cases under local anæsthesia when the general condition well permit. This makes the first twenty-four hours of convalescence decidedly more comfortable and also definitely reduces the danger of inhalation pneumonia.

Technic and Methods of Operation.—Our results, especially our primary mortality in these acute cases, will depend largely on two factors: (1) Technic, and (2) proper judgment as to the kind of procedure to employ.

As an introduction to the discussion of these two factors we would state that it is believed that in any case in which the viability of the strangulated gut is in question a two-stage operation is *always* indicated, and that the abdominal cavity should never be opened elsewhere than at the site of the hernia at either the primary or secondary operation. The following points in technic will serve to give the reasons for the above statements:

Technic.—In inguinal herniæ the routine incision for radical cure in uncomplicated cases, parallel to Poupart's ligament, is generously made, but in femoral herniæ this incision is shortened at the top and lengthened below and slightly curved outward so as to carry it over the femoral canal in order to give ready access to the lower end of Poupart's and all of Gimbernat's ligament, as described by Moschcowitz, Tupper, Lotheisen and others.

The author believes it is rarely necessary to actually divide Poupart's ligament in dealing with strangulated femoral herniæ. The constriction of the femoral canal can, on the other hand, be relieved by one of two methods. (1) By merely nicking the under surface of this ligament or partially dividing Gimbernat's ligament, or (2) (and this method is much preferred and has been found very satisfactory in several recent cases) the femoral ring or point of constriction can be *stretched* by the aid of two small retractors so that the hernia can be reduced or, in cases in which it is necessary, room enough can be obtained in which to pull down healthy intestine far enough to allow one to do resection *in situ* outside of the abdominal cavity and outside of the femoral ring.

This technic of stretching the femoral ring has been carried out in cases under local as well as under general anæsthesia with very satisfactory results. Partial severance of Gimbernat's ligament serves to give added room when necessary, and does not destroy an anatomical structure which is absolutely necessary for later radical cure. The severance of Poupart's ligament, it is believed, is contraindicated except in extreme cases because local wound sepsis in this region is very liable to follow and a necrosis of the ligament is liable to ensue with eventual weakening of

this part of the abdominal wall and unsatisfactory results from later attempts at radical cure of the hernia.

Questions of Judgment.—(*a*) Indications for the two-stage operation; and (*b*) contraindications against opening the abdominal cavity above or at any other site than at the inguinal or femoral openings.

(*a*) It is believed that the two-stage operation is always, and invariably, indicated (1) when there is reasonable question of the viability of the strangulated segment of intestine, and (2) when resection is unquestionably necessary. This belief is further confirmed by a review of hospital case histories showing nearly 100 per cent. mortality in cases where an attempt to resect and anastomosis at the primary operation is made.

If a hernia has been strangulated long enough or tight enough to destroy the vitality of the contained segment of intestine, then the patient has of necessity absorbed enough toxin from this area to make a one-stage operation unsafe. This point is further confirmed by the satisfactory convalescence made by those in whom a two-stage operation with immediate drainage of the involved, congested gut is done. This drainage should be kept up, not for a few days only, but for several weeks, until all signs of toxæmia have disappeared, wound sepsis has cleared up, and the patient is in a sufficiently improved condition for the anastomosis and radical cure of his hernia. Here again hospital case histories show the mistake in judgment of attempting the second operation much before the lapse of at least three weeks.

(*b*) The abdominal cavity need not and should not be opened other than at the site of the hernial opening in order to do the second stage of the logical two-stage operation.

Contraindications are: (1) danger of peritonitis; (2) difficulty of freeing ends of intestine from hernial opening when approached from within the abdomen, without, of necessity, soiling the peritoneum and making drainage of the wound necessary; (3) the ease with which an anastomosis can be done outside the hernial ring, the intestine returned to the abdominal cavity, and a radical cure be done with provision made for drainage only of superficial tissue; and (4) the greater risk of the double as contrasted with the single operation at this time.

The routine procedure of two-stage operation in strangulated femoral hernia is outlined below:

Anæsthesia preferably local; opening of sac to determine condition of contents; stretching of femoral ring, possibly further aided by nicking Gimbernat's ligament; pulling down of healthy intestine; resection of devitalized gut; insertion of Mixter drainage tubes into each cut end; stay sutures holding intestinal ends well outside of wound; small drainage wicks; closure of skin to tubes; after a lapse of three weeks, local anæsthesia; careful freeing of ends of intestine from edges of wound; further stretching of contracted tissue about femoral ring; end-to-end anastomosis; cleansing of joint; return to abdominal cavity through

relaxed femoral opening; radical cure of hernia with drainage to superficial tissue only.

Three recent cases done by this technic made splendid recoveries when the chances seemed poor and two other cases, one femoral and one inguinal, done over a year ago, show no signs of recurrence of their herniæ at the present date.

The principal advantages of the method described and used in a series of twelve cases are:

1. The shortest and least traumatizing primary operation possible when the patient is in poorest condition.

2. The great benefit from prompt and continued drainage of the strangulated gut.

3. The minimum risk of peritonitis; the operation being practically extraperitoneal and the risk from peritoneal infection is therefore practically *nil*.

4. Avoidance of cutting structures like Poupart's ligament which do not tend to heal readily and the obtaining of sufficient room for reduction of the hernia—or for resection and later repair of the hernia—by the method of stretching the femoral ring.

5. The strong evidence against opening the abdomen elsewhere to do resection or anastomosis as evidenced by the high mortality in the one-stage operation.

It is, of course, realized that the advocacy of the two-stage, drainage-*in-situ* operation admits of the probability of more or less local sepsis in the hernial wound, but results so far, both immediate and at the end of one year, still lead us to believe that the risk of such wound infection is of comparatively little importance in comparison with the benefits derived from the intestinal drainage effected and the materially lowered mortality when this is done.

Such technical errors as the followng are found on analysis to be the definite cause of high mortality and illustrate our points of discussion:

1. Strangulated inguinal hernia, seventy-two hours duration. Poupart's ligament severed. Resection of intestine for gangrene. Drainage *in situ* with Mixter tubes, but second operation for end-to-end anastomosis done after the lapse of only one week in a dirty field and followed by general peritonitis and death.

2. Strangulated inguinal hernia, forty-eight hours duration. Resection and faulty end-to-end anastomosis done *in situ*, one-stage operation followed by intestinal obstruction; later lateral anastomosis, intestinal obstruction and death.

3. Strangulated inguinal hernia, forty hours duration. Median abdominal incision. Intestine ruptured in attempt to free it from the sac from within. Patient died of general peritonitis.

4. Strangulated inguinal hernia, seventy hours duration. General condition only fair. Ether. Resection and end-to-end anastomosis, one-stage operation. Death pneumonia. General peritonitis.

5. Strangulated femoral hernia. Ether. Median abdominal in-

cision. Resection and end-to-end anastomosis of intestine. Radical cure of hernia. Died of secondary shock. One-stage operation.

6. Strangulated inguinal hernia, three days duration. Gangrenous sac and intestine. End-to-end anastomosis after resection *in situ* necessitating drain to inguinal canal and failure of anastomosis to hold because of sepsis present. Fecal fistula in inguinal canal necessitating opening abdomen at later (but too early for walling off) date for partial obstruction and death from general peritonitis.

It is believed from the results obtained, even in our very limited number of cases, that the procedure advocated should more often result in the recovery of the patient than the more formidable one-stage operation which is so often attempted by surgeons with the belief that the case is a border-line case and probably will stand the shorter one-stage resection and anastomosis rather than the more prolonged confinement necessitated by the two-stage operation. But this very point of judgment is what this paper wishes to call attention to, and to emphasize the fact, based on past poor results, that, as stated above, any strangulated hernia that requires resection of intestine of necessity requires the two-stage operation.

We are positive that many more lives will be saved by this procedure than if the old method, with its uncertainty of outcome, is adhered to.

It is desired to call attention to a rather unusual but successful method of dealing with an irreducible scrotal hernia of the bladder of long standing.

The case history, technic employed, and results are as follows:

A. T., fifty-six years old, an Italian laborer doing heavy work in lumbering camp for many years, had one week previously entered a large general hospital where a diagnosis of hernia of the bladder, enlarged prostate and hypertension had been made and operation advised against because of his general appearance, general condition, weight, and the nature of his hernia. He was later seen by his local doctor who referred him to the author for operation.

For nineteen years patient has had a left scrotal hernia of large size. He has always had great difficulty and much pain in reducing it, and for the past four years has been unable to do so at all. In the past year has had great difficulty in urination, but has found that persistent manipulation of his scrotum, especially in making motions of a more or less rotary character, greatly facilitated the passage of urine and that the hernia is smaller after urination is completed. The bowels are regular without medicine and he has no other symptoms except urinary urgency and difficulty in starting the passage of water.

Physical Examination.—A short, thick-set, large-framed Italian weighing 375 pounds. Mouth and throat not remarkable. Heart and lungs negative except for slight hypertrophy of heart consistent with

his size. Blood-pressure systolic 150, diastolic 80. Abdomen very prominent. No masses or tenderness. Left side of scrotum contains a large, soft, fluctuating tumor, the size of a large grape fruit. It is not reducible and apparently contains fluid. Rectal examination shows a very slightly enlarged, firm prostate. Attempts to pass a catheter or cystoscope unsuccessful. Catheter meets a definite obstruction after it has passed the prostate apparently. After voluntary micturition tumor of scrotum is diminished about one-half in size, but is still irreducible and catheterization is still impossible. Urine negative.

Diagnosis.—Scrotal hernia of bladder and probably omentum. Operation advised and accepted with the reservation that the testicle should not be sacrificed unless absolutely necessary. Patient sent to hospital for forty-eight hour pre-operative bi-daily local preparation. Given methylene blue three times a day for two days previous to operation in the effort to stain the bladder wall so as to render it more easily distinguishable from surrounding structures.

Operation.—A most skillful, lightly given ether anæsthesia by Dr. Frank L. Richardson rendered the operative difficulties much less. Usual left inguinal incision carried well down into scrotum. Great difficulty experienced in locating the part of the sac where the bladder was not adherent. Sac finally opened and found to contain bladder only, which was everywhere firmly adherent. It was found impossible and inadvisable to attempt to dissect bladder free from its almost complete surrounding of adhesions. It was impossible to dissect even the cord from the sac and bladder wall and, respecting the patient's desire to save the testicle, it with the cord, sac and bladder were freed from the scrotum, invaginated together, and pushed *en masse* gently through the stretched inguinal canal into the abdominal cavity and a radical cure of the left inguinal hernia done. Immediately after operation the patient was catheterized with great ease. He made an absolutely uneventful convalescence, voiding regularly without difficulty or pain, left the hospital on the twentieth day and has been free from symptoms since. When last seen about six months after operation he had had no pain from his abdominally housed testicle, no urinary symptoms, and no recurrence of his hernia.

The point we desire to emphasize in reporting this case is the possibility, when extensive adhesions make wide dissection of such a hernia inadvisable, of placing an adherent cord and testicle within the abdominal cavity, together with its adherent hernial sac (or bladder), doing a radical cure of the hernia and expecting a favorable, symptomless outcome.

ROENTGEN EXAMINATION OF THE ABDOMINAL ORGANS FOLLOWING OXYGEN INFLATION OF THE PERITONEAL CAVITY*

By Arthur Stein, M.D.
of New York
Associate Visiting Gynecologist, Lenox Hill and Harlem Hospitals
and
William H. Stewart, M.D.
of New York
Roentgenologist, Lenox Hill and Harlem Hospitals

The introduction of air or gas into body cavities as an adjuvant of röntgenology is not, as is sometimes erroneously assumed, entirely new, for the procedure has been repeatedly employed in the past as a diagnostic aid in röntgen examination of the urinary bladder, renal pelvices and of the knee-joint in particular. Credit for the original idea of air inflation of the peritoneal cavity for diagnostic purposes must be given to Kelling, who, in 1902, employed this method of inspecting the abdominal contents of two human beings, one a case of ascites, the other a carcinoma of the stomach in a woman with very relaxed abdominal coverings.

Eight years later, in 1910 and 1911, Jacobaeus of Stockholm revived the method and emphasized the safety of the abdominal puncture in these cases on the basis of over twenty experiments on cadavers in which the trocar was pushed through the abdominal wall and invariably reached the peritoneal cavity without damaging the viscera. Excellent results were obtained by him later on in seventeen cases of ascites, including three very remarkable diagnoses (metastatic nodule in the liver, gastric cancer, general carcinosis of the intestine). A monograph on the subject of laparo- and thoracoscopy under air inflation was published by him in 1913, wherein conditions are described as relatively favorable in the living subject because of the yielding and elastic character of the intestinal walls.

It was only a step, although a most important one, to the application of the method of abdominal inflation to the röntgenological technic. Weber, working in the Private Institute for Röntgen Diagnosis of Doctors Eugen Weber and V. von Bergmann in Kiew, in January, 1912, conceived the idea, based on the Röntgen examination of a bladder filled with oxygen, showing a good röntgenogram of the hypertrophied prostate, that the introduction of sterile inactive oxygen or air into the abdominal cavity might help to render visible a number of organs, tumors and abdominal areas which heretofore had been more or less inaccessible to Röntgen examination. Experiments on animals and on fresh cadavers of adults and children entirely confirmed his

*Read in part before the American Association for Thoracic Surgery, June 9, American Gastro-enterological Society, June 10, and the American Surgical Association, June 16, 1919.

theory. His röntgenograms showed that the following viscera and areas may be rendered visible by means of gas inflation of the abdomen: (1) The liver and spleen as a whole, including the region of the gall-bladder. (2) Coils of the large and small intestine without bismuth filling. (3) The pyloric portion of the stomach. (4) The walls of the stomach and large intestine with gas contents. (5) The bladder filled with urine. (6) Parts of the mesentery. (7) The subphrenic space, not readily accessible to diagnosis. (8) Many intra-abdominal tumors.

He emphasizes the far-reaching importance of air or oxygen inflation of the abdominal cavity for experimental and diagnostic röntgenology and lays stress on the value of the method for obtaining good röntgenograms of the liver and biliary region as well as for the röntgenographic representation of tumors and inflammatory swellings.

In 1912, Lorey, in connection with the demonstration of a peculiar case of ascites, pointed out that after the introduction of air or nitrogen into the abdominal cavity it was possible to demonstrate the contours of the spleen and liver with great clearness and to recognize the existence of tumors projecting above the surface as well as other pathological changes. The method was employed by him after puncture of ascites in a case of hepatic cirrhosis with good results.

Systematic experiments for the purpose of rendering the liver accessible to röntgenography were carried out in 1914 by Rautenberg, who introduced air by puncture into the abdominal cavity in diseases of the liver complicated by ascites with the object of obtaining more distinct contours of both liver and spleen. He fully appreciated the diagnostic value of the method and recommended it as affording remarkable information concerning the organs situated below the diaphragm. Conditions such as carcinoma of the liver, sarcoma of the spleen, etc., were recognized by means of this method. He contributes four interesting illustrations, one of which shows peritoneal carcinosis and cancer nodules in the diaphragm. The liver in this case was seen to be smooth and the spleen normal following puncture of ascites and oxygen inflation of the peritoneal cavity. In a patient with hepatic cirrhosis who was röntgenographed in the left lateral position the liver was revealed misshapen and irregular. In a case of degeneration of the heart muscle with general stasis röntgenographed in the same position the liver was shown to remain convex and vaulted. A normal pneumo-peritoneum taken in the left lateral position showed the right hepatic lobe spread out flat and horizontal.

Another contribution to the subject was made by Meyer-Betz, who in 1914 discussed the clinical importance of röntgenographic representation of the liver by means of air or oxygen inflation of the free abdominal cavity. He pointed out that under correct employment this procedure affords valuable assistance in the determination of the starting point of tumors in the abdomen and their relation to the other organs of the abdominal cavity.

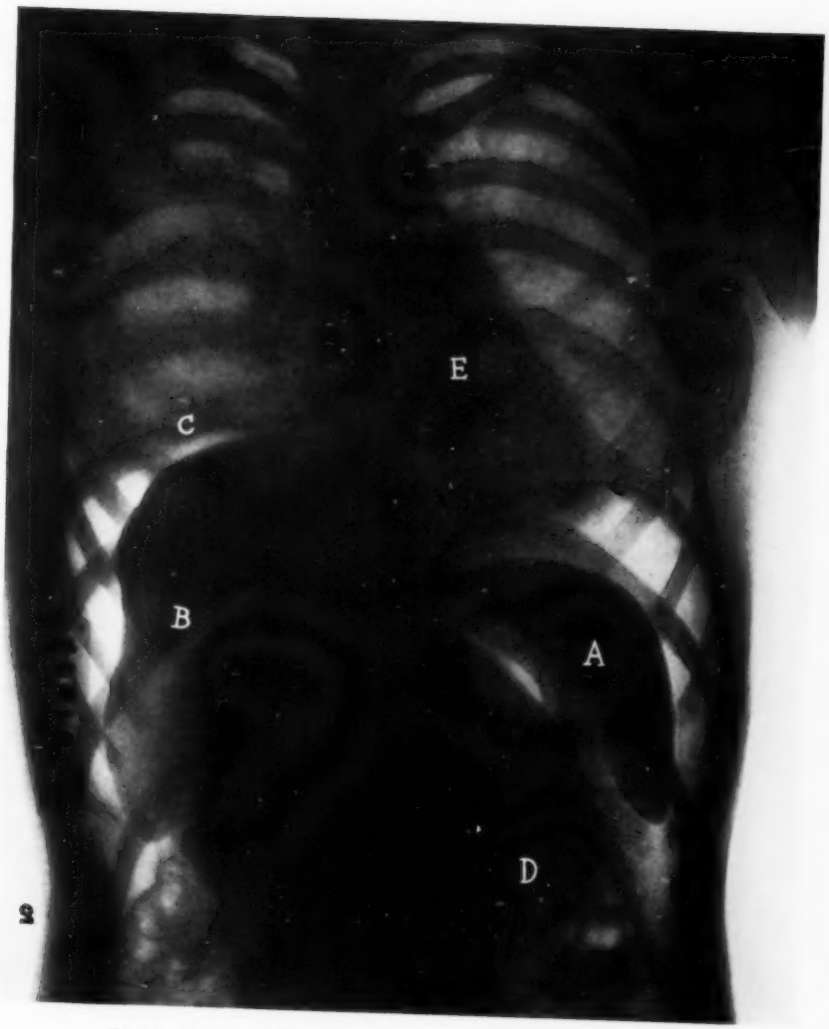

FIG. 1.—*A*, spleen; *B*, liver; *C*, diaphragm; *D*, left kidney; *E*, heart.

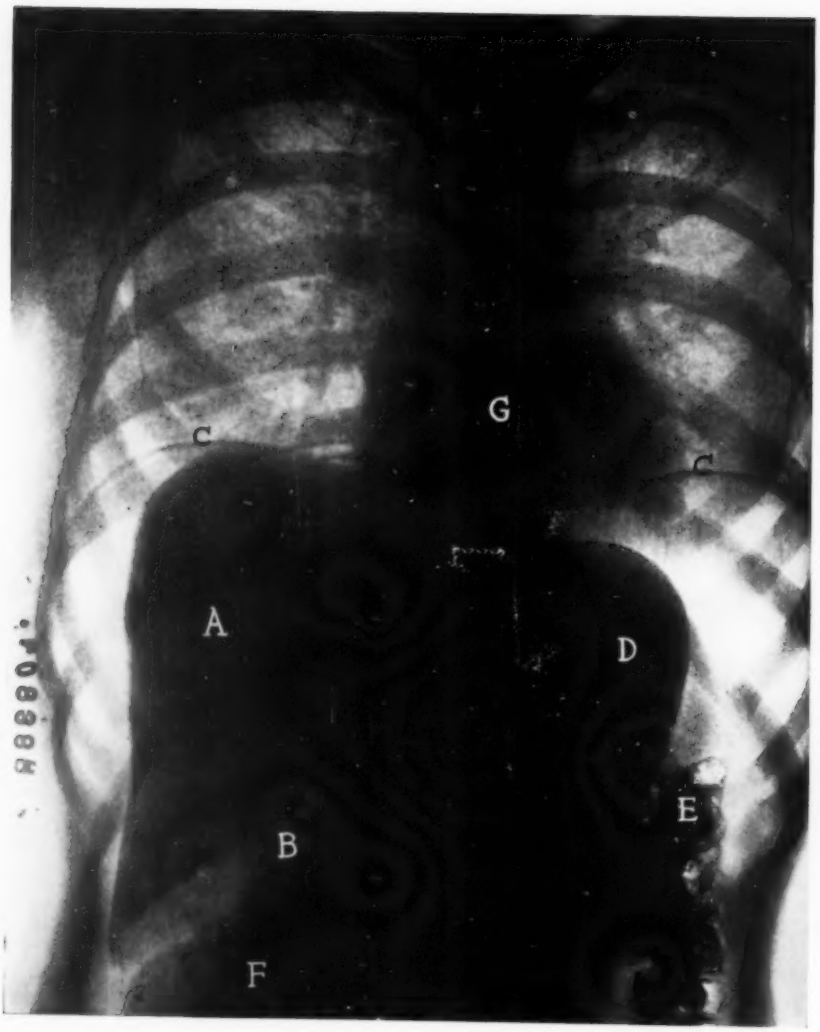

FIG. 2.—*A*, liver; *B*, gall-bladder; *C*, diaphragm; *D*, spleen; *E*, splenic flexure of colon; *F*, right kidney; *G*, heart.

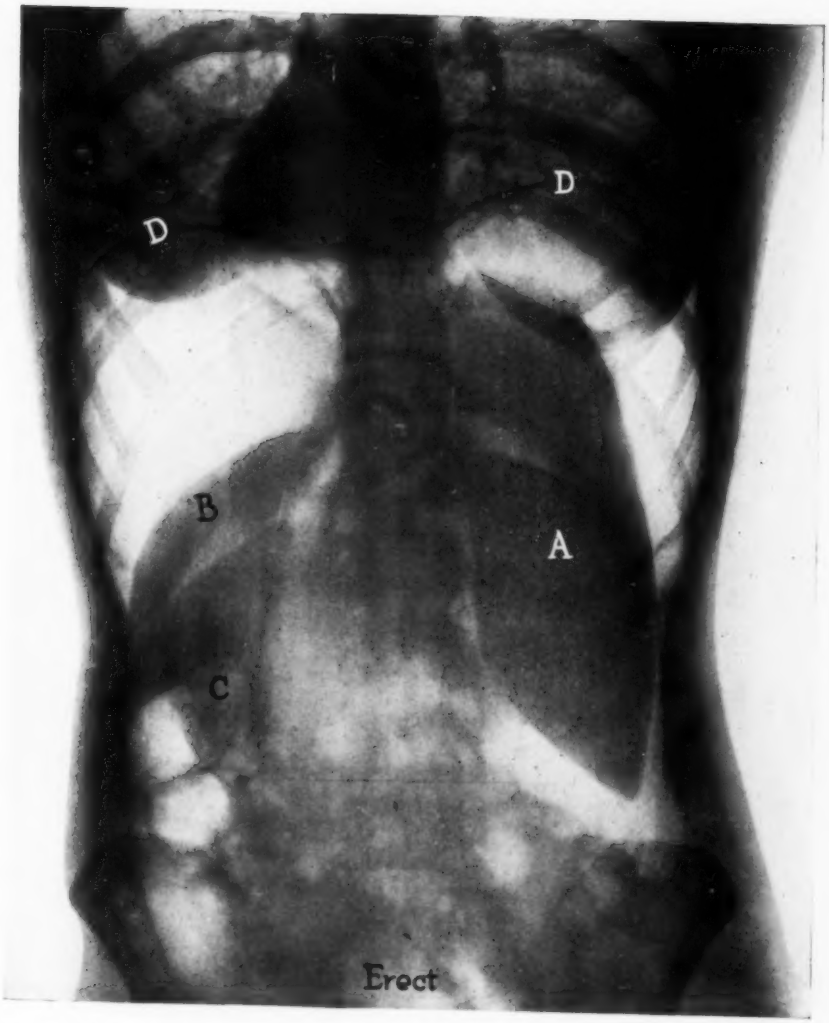

FIG. 3.—Patient in erect position. *A*, liver; *B*, spleen; *C*, right kidney; *D*, diaphragm.

FIG. 4.—Patient in erect position. *A*, liver; *B*, spleen; *C*, right kidney; *D*, left kidney; *E*, splenic flexure; *F*, colon descendens.

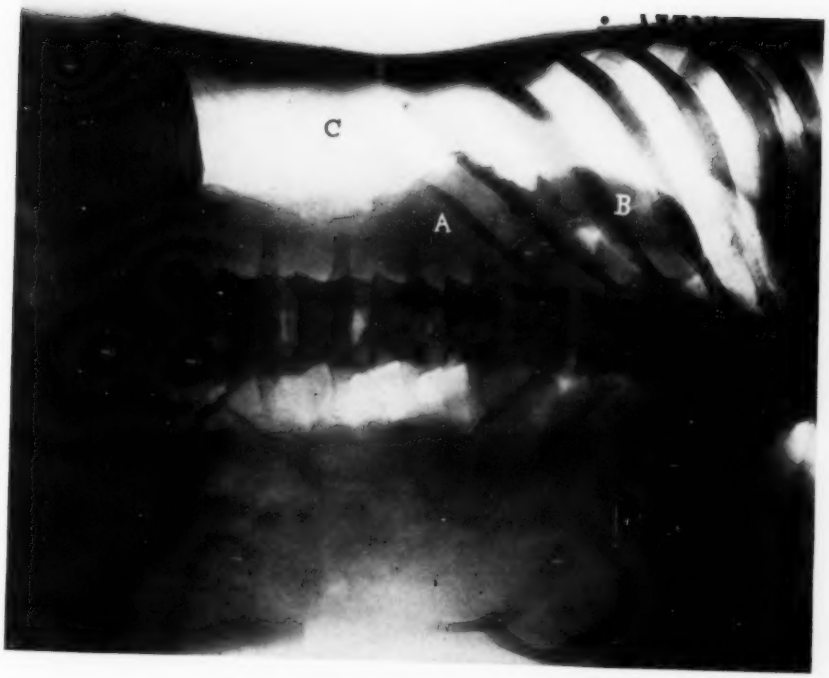

FIG. 5.—*A*, kidney; *B*, spleen; *C*, oxygen.

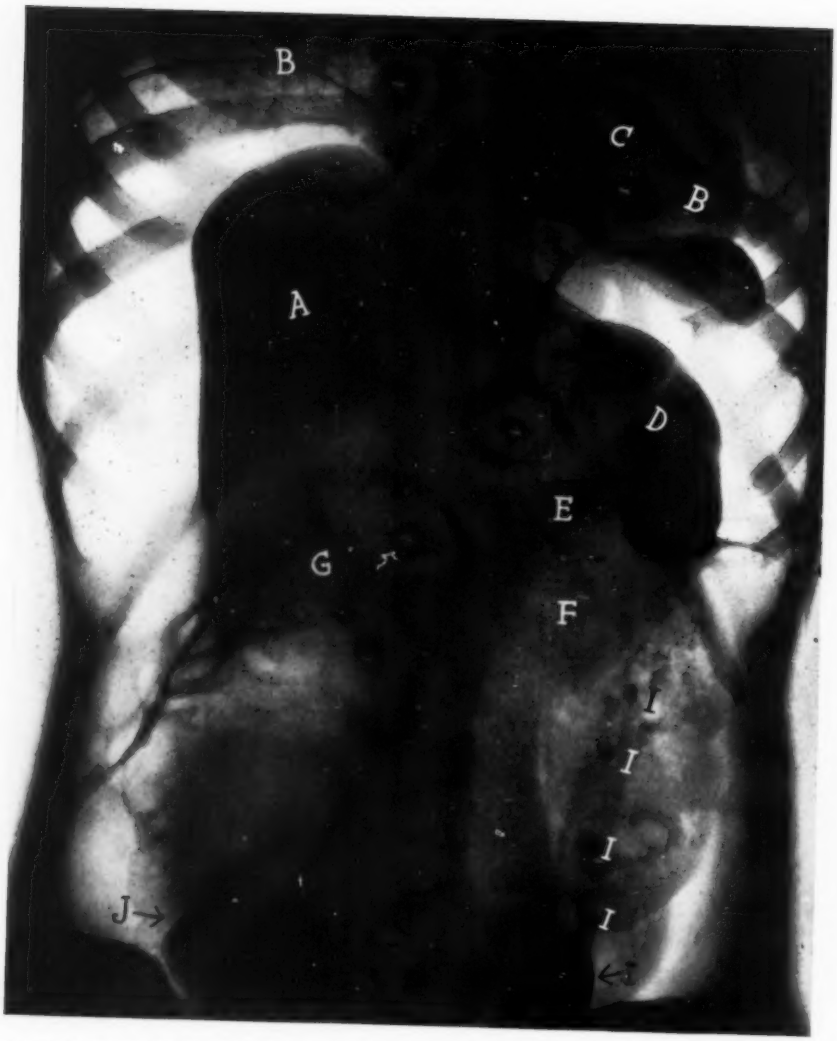

FIG. 6.—*A*, liver; *B*, diaphragm; *C*, heart; *D*, spleen; *E*, pedicle of spleen; *F*, left kidney; *G*, right kidney; *H*, four enlarged mesenteric glands; *I*, enlarged cystic ovary; *J*, mass involving right tube and ovary.

FIG. 7.—*A*, enlarged lobulated spleen; *B*, diaphragm.

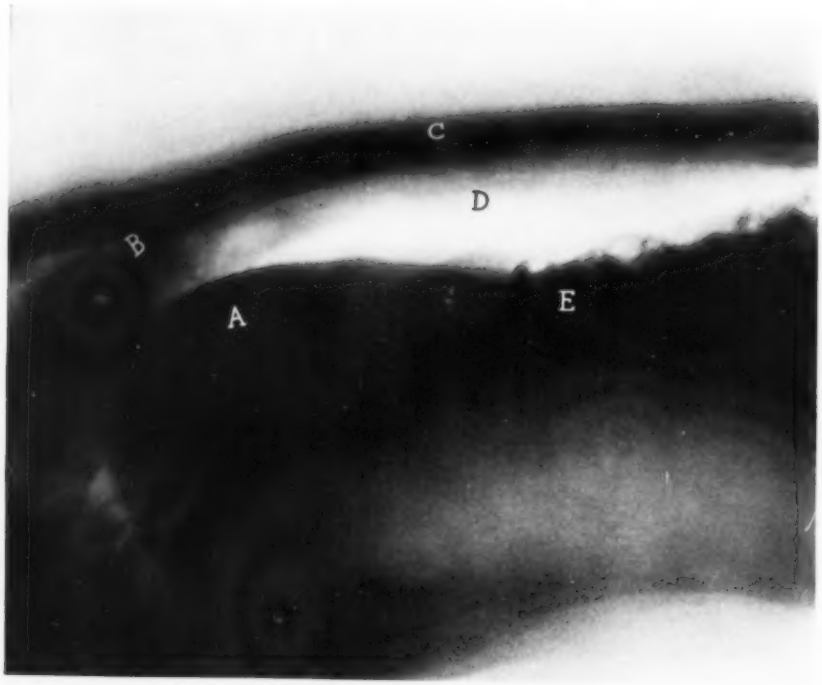

FIG. 8.—*A*, liver; *B*, diaphragm; *C*, abdominal wall; *D*, oxygen; *E*, intestinal coils.

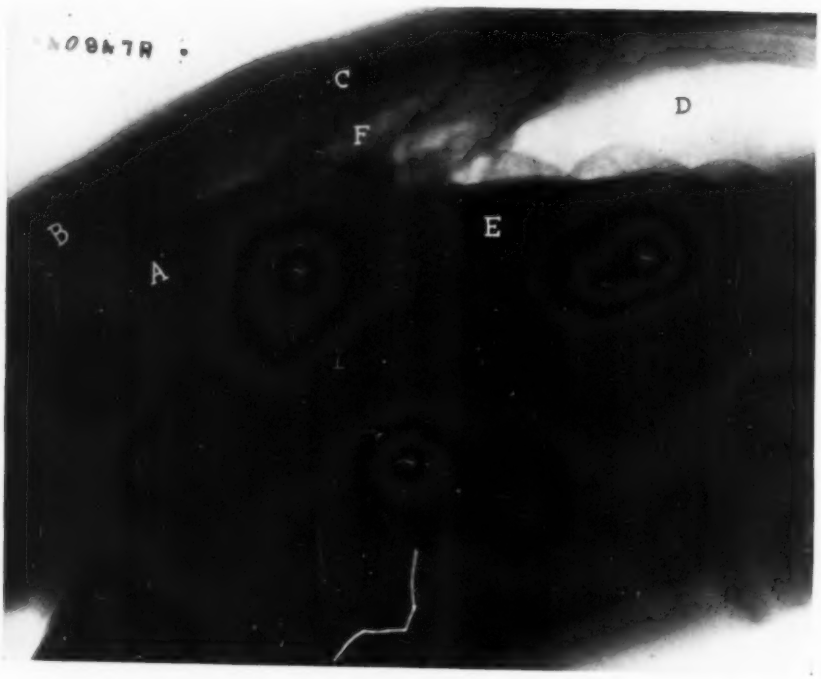

FIG. 9.—*A*, liver; *B*, diaphragm; *C*, abdominal wall; *D*, oxygen; *E*, intestinal coils; *F*, intraperitoneal adhesions.

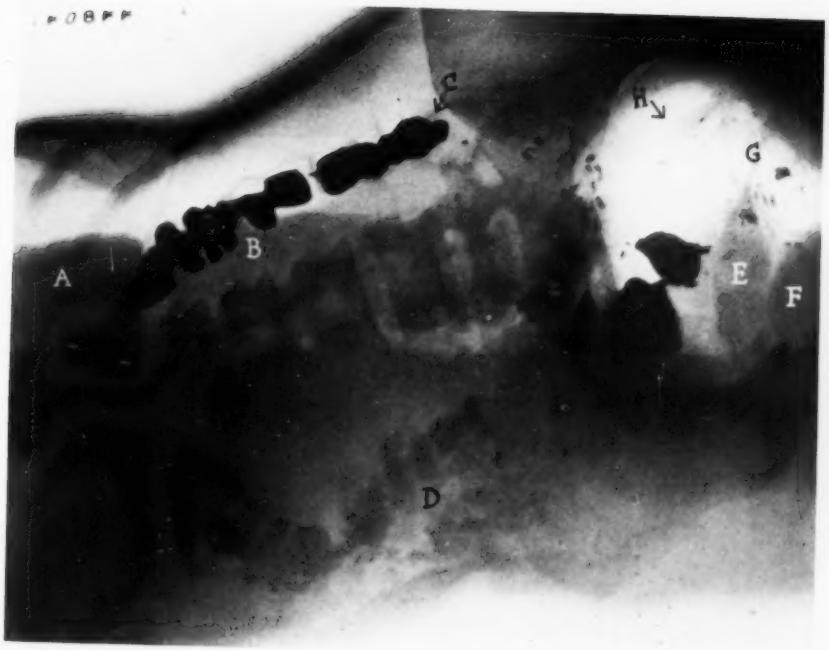

FIG. 10.—*A*, spleen; *B*, kidney; *C*, colon descendens; *D*, cæcum; *E*, fundus uteri; *F*, bladder; *G*, broad ligament; *H*, left ovary.

FIG. 11.—*A*, myoma uteri; *B*, stretched round ligaments; *C*, pedunculated fibroid.

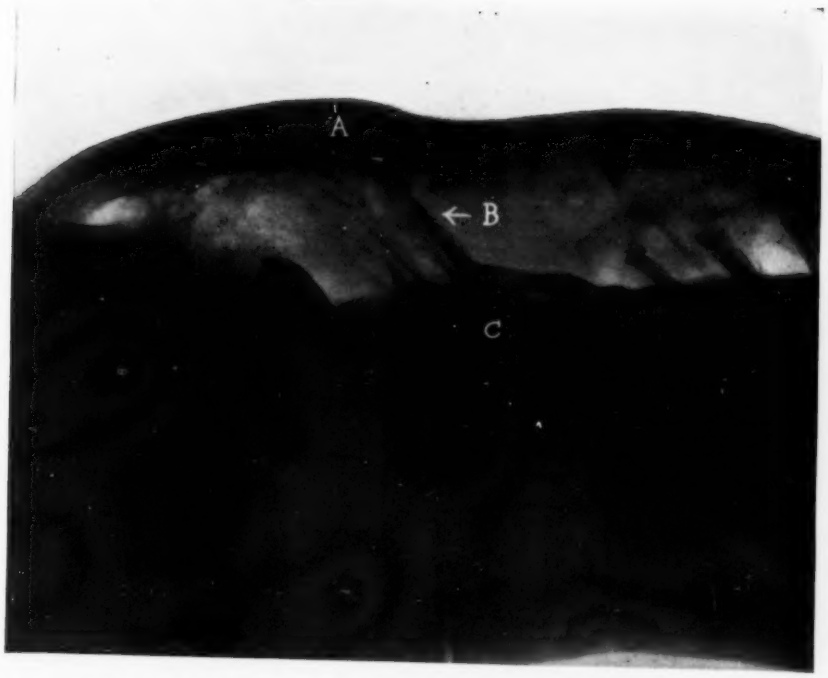

FIG. 12.—*A*, abdominal wall; *B*, intraperitoneal adhesions; *C*, coils of intestines.

FIG. 13.—*A*, left kidney.

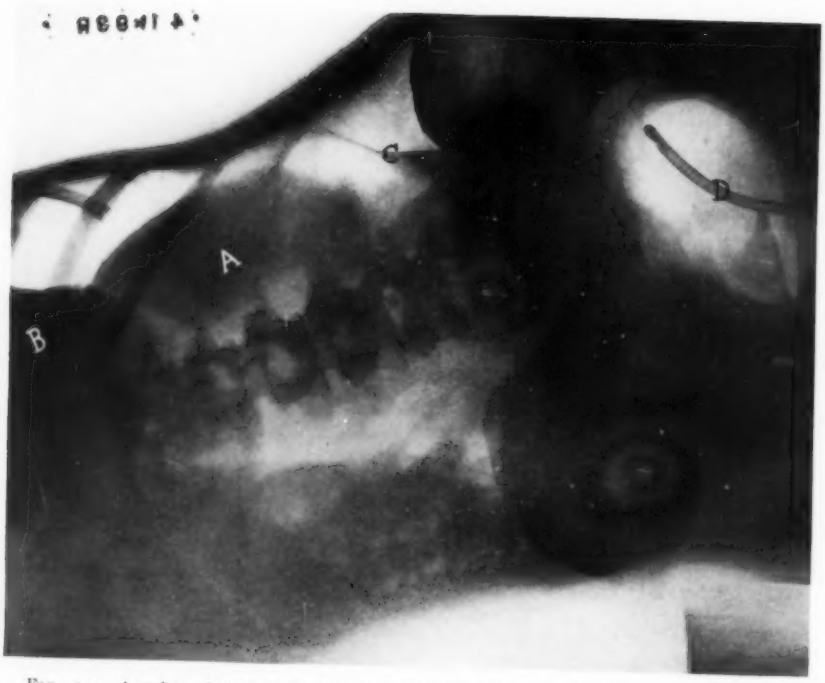

FIG. 14.—*A*, enlarged right kidney; *B*, liver; *C*, adhesions; *D*, bladder distended with air.

In November, 1918, Goetze, in apparent ignorance of the work of his German predecessors along these lines, with the exception of Rautenberg, reported very remarkable röntgenographic data concerning nearly all of the abdominal organs on the basis of a large number of experiments on living subjects secured by filling the abdominal cavity with oxygen before taking the röntgenograms.

Judging from the accessible literature the diagnostic method of oxygen or air inflation by abdominal puncture in combination with röntgenology has not been introduced in France, where röntgenological control of therapeutic pneumothorax was proposed by Rist and Maingot in 1912.

In a Paris thesis (1912) on radioscopy and radiography of the spleen, Le Page mentioned inflation into the joints and into the stomach as a general diagnostic procedure. Gastric inflation was employed not only for the examination of the stomach itself, but also for the diagnosis of pericardial exudates.

Béclère advocated inflation of the stomach and colon for the examination of the lower surface of the liver and the search for biliary calculi. By means of this procedure the shadow of the spleen was successfully projected on the fluoroscopic screen and the outlines of the organ were shown with the existing changes in configuration.

In 1914, in this country, W. H. Luckett and William H. Stewart demonstrated röntgenographically the ventricles of the brain in a case of fractured skull where air had invaded the interior. In this connection it is interesting to note that ventriculography in the form of air injection into the cerebral ventricles, followed by X-ray examination, has been recently carried out by W. E. Dandy, who describes the method as invaluable in internal hydrocephalus and of great practical value in the diagnosis and localization of many intracranial conditions. He points out that the outlines of the lateral cerebral ventricles can be sharply outlined by the Röntgen ray if air is substituted for cerebrospinal fluid. This injection of air into the ventricles had no deleterious effects in twenty children between six months and twelve years of age.

After this experience and a careful study of the new method we decided to give the matter a fair trial in order to satisfy ourselves whether by improving on the technic we might show distinctly the parenchymatous organs in themselves as well as in their relation to each other and any pathological changes which might be present in these organs.

The simple method employed by us is as follows: After the patient is prepared in the usual manner for Röntgen examination (thorough cleaning out of the bowels and emptying of the bladder) he is put flat upon his back and the abdomen is then inflated with about three to four litres of oxygen. The whole outfit required for this procedure consists of an oxygen tank to which is attached a rubber bag (such as is used with the gas-oxygen apparatus for anæsthesia) with a capacity of about one gallon or four litres. To this bag is attached a small rubber tube which can be easily connected

with a regular lumbar-puncture needle. The spot where the needle is to be inserted is sterilized with iodine and the skin rendered insensate by an injection of novocain-adrenalin solution. The spot from which in our judgment it is easiest to inflate the abdomen is two to three fingers to the left of the umbilicus and about one and a half inches below it. This procedure is very simple. Anyone who has had surgical experience can easily gauge the thickness of the abdominal wall. Our practice is to push the needle to a point where it touches the fascia; then we stop for one or two seconds. After that the needle is pushed through fascia, muscle and peritoneum without any difficulty. The plug is then removed from the needle and the needle is connected with the rubber tube. A slight pressure on the bag will now inflate the abdomen with oxygen. As a rule, this takes between four and five minutes and the amount of oxygen to be introduced varies between three and four litres or nearly one gallon. When the abdomen is entirely distended the patient usually complains of a sensation of fullness and slight pains in the shoulders (the latter apparently due to pressure against the diaphragm). As far as the fate of the oxygen is concerned, it is usually absorbed without any trouble within twenty-four hours.

The procedure necessarily stands and falls with the safety of the peritoneal inflation with oxygen. Reliable evidence in this respect is not wanting. Dr. W. S. Bainbridge of this city has used oxygen in intra-abdominal administration with uniformly favorable results in more than 125 laparotomies. The therapeutic method of oxygen injection into the peritoneal cavity with immediate closure of the abdomen and gradual absorption of the gas was first employed by him in 1903 and reported in 1908 and 1909. Godwin, in England, on the basis of four years' favorable experience recommends intraperitoneal injections of oxygen during and after abdominal operations. Both these writers endorse the employment of the method after removal of large tumors to overcome negative abdominal pressure, for the prevention of primary or recurrent adhesions, in tubercular peritonitis, and in general septic peritonitis. Far from being in the least injurious, oxygen in the abdominal cavity has been found to lessen post-operative shock, nausea and vomiting. The gas is non-irritative to the peritoneum and the abdominal organs.

Now a few words about the apparent danger of puncturing the intestines. Experience has shown us that the elasticity of the intestines permits them to recede before a sharp intruding body such as a needle, provided that caution is used and the needle advanced slowly. We ourselves have encountered no difficulties in this respect and have experienced no untoward effcts. Our experience has been absolutely in accordance with the findings of other writers mentioned in this paper.

Within two to three hours after inflation the patient should be referred to the röntgenologist. This method permits the Röntgen examination to be made in the most varied positions, standing or lying down, and all of the

solid organs are revealed with a clearness and distinctness heretofore impossible to attain.

For example, in the erect position, due to the fact that oxygen always rises to the highest point, we were able to secure beautifully contrasting röntgenograms of the diaphragm, liver and in many instances the gall-bladder attached, normal spleen with its outstanding pedicle and both kidneys.

In the horizontal position, with the patient's back to the table, we were able to demonstrate some very marked post-operative adhesions between the intestines and the parietal peritoneum. We also demonstrated with great clearness a large carcinoma of the ascending colon.

In the exaggerated, lateral, Trendelenburg position (patient lying on either the left or right side in the bayonet position) we were able to demonstrate not only the normal uterus with its round ligaments, small cystic ovaries and normal bladder but also myomatous tumors of the uterus, which, as is well known, have not heretofore been röntgenographically demonstrated.

Pathological conditions, such as carcinomatosis, cirrhosis or marked hypertrophy of the liver, enlargement of the spleen and tumors of the stomach and intestines, as well as those of the genital organs, are now easily demonstrated. The procedure which we are presenting on the basis of its obvious merits promises a wide extension of the diagnostic scope of the Röntgen rays in the domain of gynæcological and general abdominal surgery.

In concluding this short report we would like to say that in our opinion this procedure is not a competitor of the opaque meal method, as the latter concerns the hollow organs of the abdomen, whereas our method is concerned mainly with the parenchymatous abdominal organs. We therefore believe that it will be a great help in the Röntgen diagnosis of the abdominal organs when used in combination with the barium meal.

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NEW INSTRUMENTS FOR PROCURING AND PREPARING AUTOGENOUS BONE BOLTS AND KEYS AND SPECIAL METHODS OF THEIR APPLICATION IN SHAFT FRACTURES

By William Lisle Bell, M.D.
of Oakland, Cal.

For the purpose of this discussion but three methods of fixation will be described.

For the performance of the simple technic involved, one right-angled motor nose (Plate 3) controls and transmits power to the instruments illustrated in addition to practically all types of rotary cutters.

The method of applying power to this rotary adjustable cross nose will be discussed later in another article if deemed worthy. The devices for this power chuck or nose consist of four cylindrical core drill saws, numbered 1, 2, 3, 4, Plate 1. Two rotary cutters (end mills) numbered 5 and 6, Plate 1; a buried saw or "submarine" cutter, Plate 5; conventional circular saws and a set of three forceps; one locking forceps for each side of the fracture, and an extensor or spreader forceps resting in projections on the locking forceps as shown in Plates 1–6.

Operation 1.—The tibia. Where not too comminuted or excessively oblique, the spine of the tibia is incised with fine hand saw or more quickly by circular saw, Fig. 1 (Plate 2). Saw cut made across base of peg just deep enough to join longitudinal saw cuts and for the *width* of peg base only. The bone should not be weakened by a cross cut long and deep enough to completely free the peg. With this saw cut as a guide a few thrusts of a small drill, as in Fig. 2 (Plate 2), completely free the peg. Drill is shouldered as shown in illustration to limit its depth. This method has proved much more accurate, quicker and better in every way than any sort of chisel. A similar cut is made in the opposing fragment, half as long and the key freed in the same manner.

The tibial spines now present trough-shaped slots which are shaped convexly by inserting rotary concave end mill No. 5 (Plate 1) in the manner drawn in Fig. 3 (Plate 2). The sliding key is now grooved on opposite sides by rotary bit No. 6 (Plate 1) and Fig. 4 (Plate 2). Key is now rotated until upper flat surface is practically horizontal and slipped back into slot from which it came, Fig. 5 (Plate 2). Fractured ends now approximated so that slots are directly continuous and concave key is thrust across half its length, Fig. 6 (Plate 2). It will be seen that this key lies on edge before removal and when replaced has been rotated about 45 degrees on its long axis. The mathematics is such that through this rotation the peg *after* shaping fills snugly the space from which it was cut.

It is evident that this operation quite firmly fixes the fracture against rotation, angulation and side slipping. The practical results substantiate

the theory and in suitable cases the fixation has been found quite rigid, yet if properly done to allow just enough limited motion to prevent splitting or snapping.

Tight autogenous work imposes too much pressure on surrounding bone and creates a tendency to snapping in key or dowel. Peri- and endosteum remain intact upon this key, and the medullary canal remains patulous. The operation requires no second incision, and may often be accomplished with ease through a one line linear incision favoring better nourished skin. The depressed position of the locking key in the completed work at this point facilitates wound closure without suture pressure. The rather abrupt notches at either end of tibia slots should be rounded with a few saw thrusts before closing. If a tibial transplant seems *absolutely* indicated in a femur this concave tibial key may be used in the femur with exactly the same technic and the key may be cut quite long if needed. The length of the key or inlay depends upon the coincidence of curves in femur and tibial crest and must be accurately measured by the surgeon's eye, for no two bones present sufficient accuracy to permit routine work.

Should the operator desire to have this tibial key fill the whole slot in the femur longitudinally, one side of the femur slot may be convexed with end mill and one side of key concaved. The ends of key are bevelled so that when key is rolled sidewise into femur slot its bevelled ends prevent its sinking below the level of surrounding bone. Two holes are now drilled and tapped between key and femur on the ungrooved side and two threaded pegs screwed home. This produces a very firm locking inlay without extraneous material of any sort for fixation.

Operation 2.—The femur. The sliding dowel method. 1. Incision. 2. The easily elevated fragment is grasped with locking forceps about 2½ inches from its end; forceps locked snugly and bone elevated about half its diameter. Cross nose armed with saw No. 4 (Plate 1) is now introduced and a dowel cut from bone *in situ*. Procedure illustrated in Plate 3. Peg loosened by cross drilling as before. Peg removed. Bone end now appears as in Plate 4. At this juncture if the opposed underlying fragment may be elevated by opposite locking forceps until approachable from the end, the next smaller saw, No. 3 (Plate 1), is used to cut the counter bore opposite the original dowel but half as long. Peg from this counter bore similarly removed. If at this stage the underlying fragment may only be elevated to the level of its fellow and not above without undue trauma, an instrument is brought into use (Plate 5). This instrument is adjustable around motor nose at any angle up to about 280 degrees, and is small enough to be backed in flush with the bore made in first fractured end. It is always possible to bring fractured ends level. After this instrument is submerged in the original bore as shown partly entered in Plate 5, the fractured ends are aligned, power applied, and the buried saw or " submarine " slipped across, thus cutting the counter opening in accurate

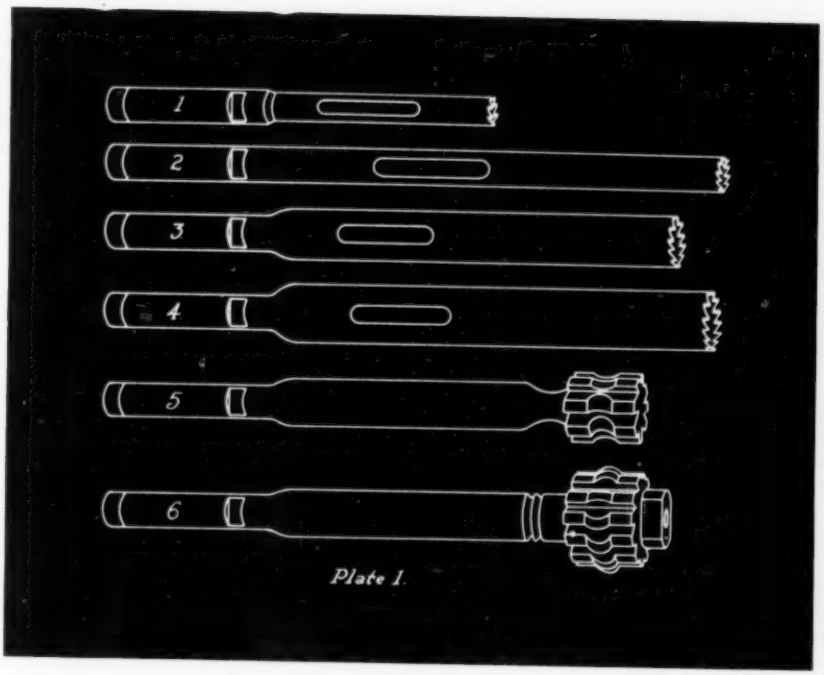

Plate 1.

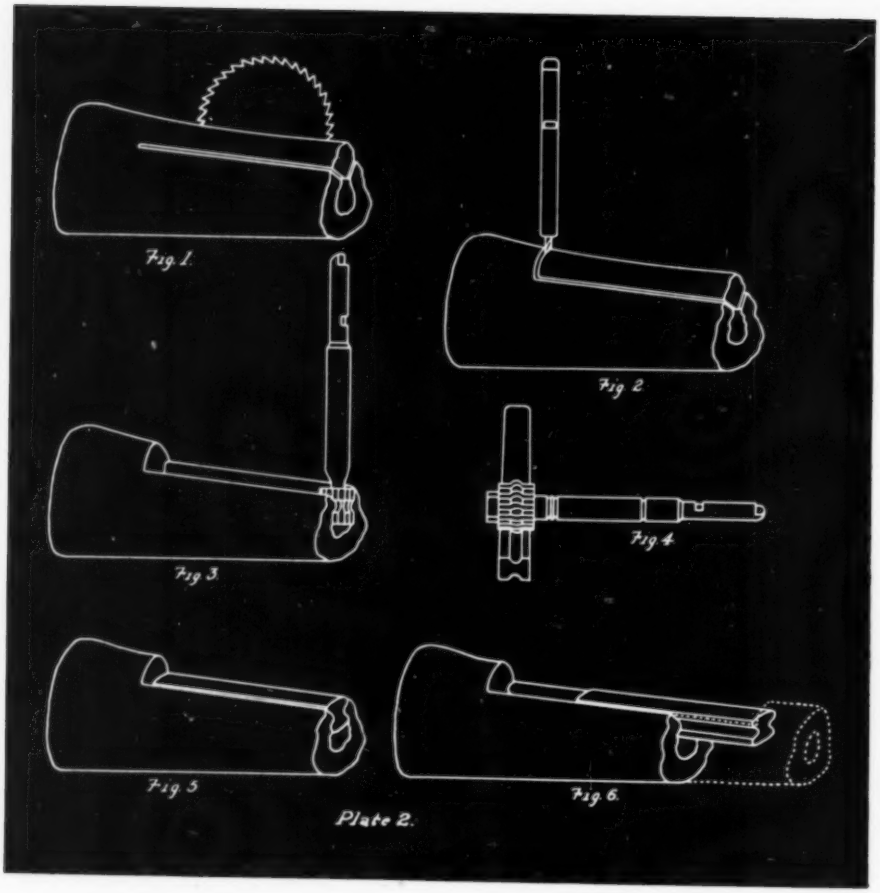
Fig. 1.
Fig. 2
Fig. 3.
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Fig. 5
Fig. 6.
Plate 2.

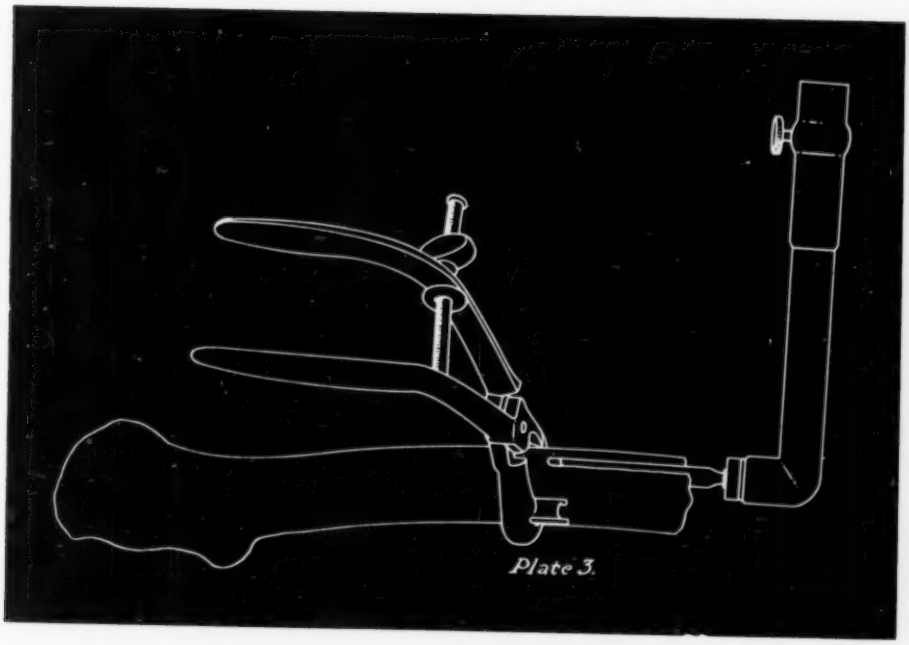


Plate 3.

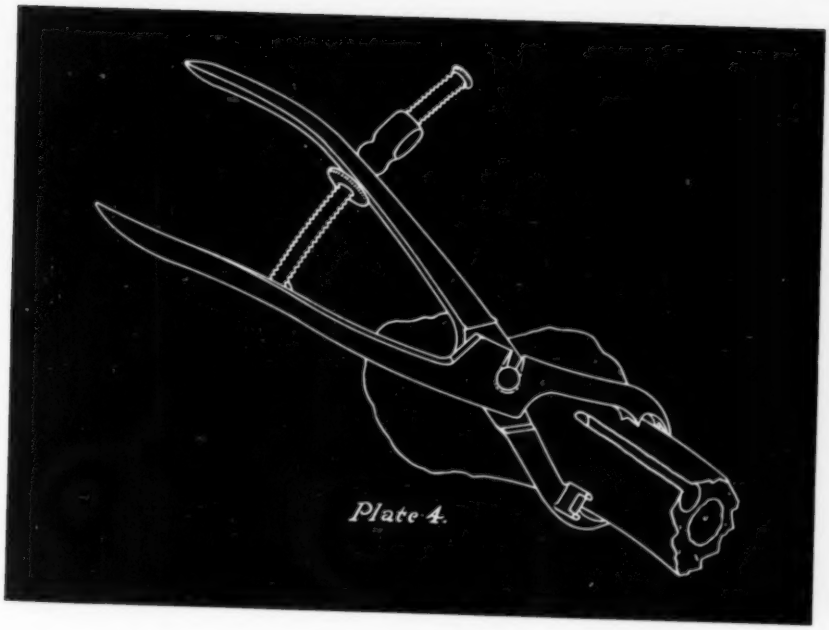


Plate 4.

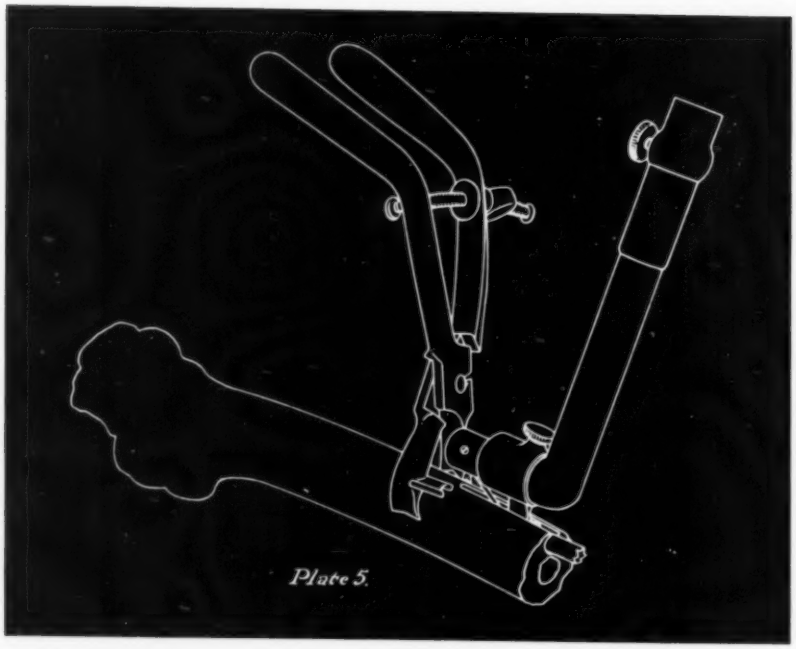


Plate 5.

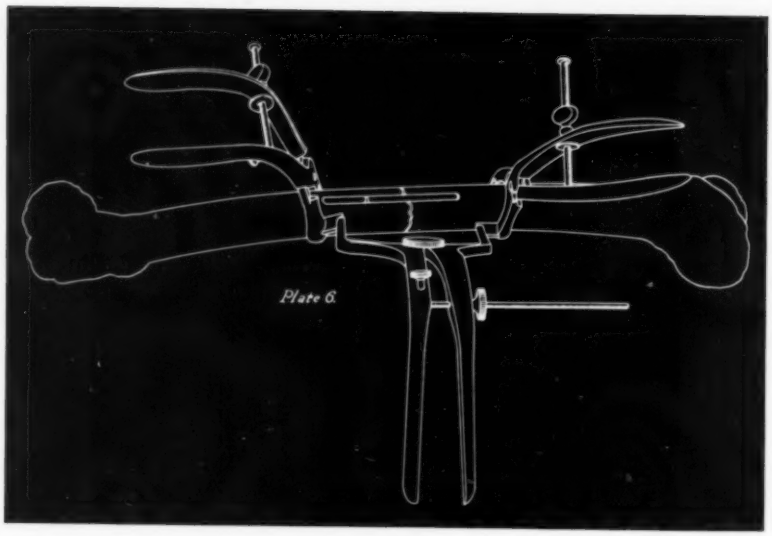


Plate 6.

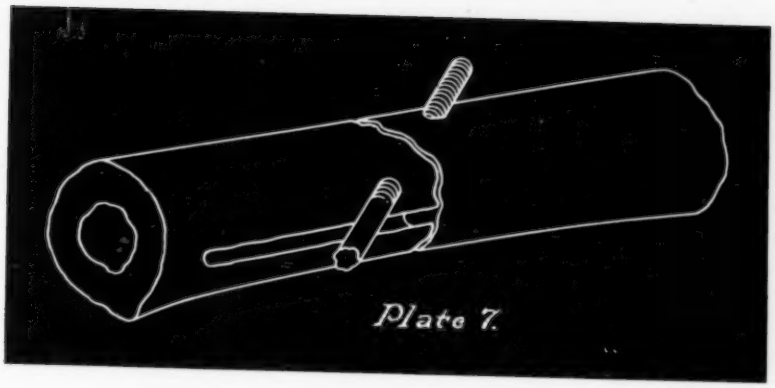
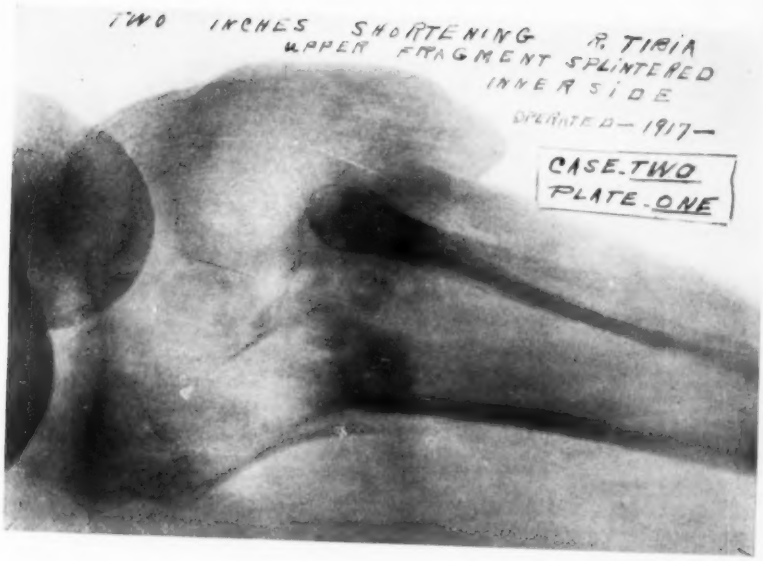


Plate 7.

CASE - ONE
PLATE - ONE
TIBIA OPERATED 1912
AUTOGENOUS CROSS SECTION
SUBSEQUENT PICTURES
LOST: PRIMARY UNION
CORRECT ALIGNMENT
PERFECT FUNCTION
SEEN TWO YEARS
AFTER
OPERATION


TWO INCHES SHORTENING R. TIBIA
UPPER FRAGMENT SPLINTERED
INNER SIDE
OPERATED — 1917 —
CASE. TWO
PLATE. ONE

SAME TIBIA 30 DAYS AFTER AUTOGENOUS
PEGGING. NO SHORTENING - SPINE CONTINUOUS.
FIRM UNION
CASE. TWO
PLATE. TWO

SAME TIBIA SOFT TISSUES AFTER 40 DAYS
BONE FIRM- MUSCLES AND SKIN SLOWLY
HEALING END RESULT ABSOLUTE EXCEPT
FOR SCARRING FROM BADLY CONTUSED AND
LACERATED SOFT PARTS.

CASE - TWO
PLATE - THREE

alignment and position. Saw now slipped back in original bore, lower fragment depressed and " submarine " removed. Motor and attachments are now put aside. Long dowel is now replaced in the bore from which it came, bone ends brought in alignment and dowel slipped across half its length.

Finished bone with forceps in place shown in Plate 6. Forceps now quickly removed by three slight turns of locking nuts beginning with middle or extensor forceps. Should it be desired to reinforce this splinting, the short peg from counter bore may be threaded and screwed across the fracture, above the sliding dowel in the manner illustrated in Plate 7. The details of this threaded peg will be touched upon in the next operations.

3. Threaded autogenous pegs. The dowels for these threaded bone screws are taken from the fractured bone, by an end approach, *in situ* and practically in one motion, as illustrated and described (Plate 3).

For cross bolting oblique or spiral fractures and in cancellous bones, necks, tuburosities, condyles, the uses and adaptations are myriad and in many cases most gratifying. Wherever possible in shaft bones, the bolt should be placed tangentially as illustrated in Plate 7. This gives more continuous support to the bolt and an infinitely stronger result.

In spiral and oblique tibial fractures are these bolts particularly useful and easily and quickly applied.

Four cases are illustrated.

Case I, in 1912, shows a suitable fracture of the tibia for either Method 1 or for threaded autogenous bolts. This was bolted.

Case II illustrates a fracture high on the tibia which held nicely with a large dowel. Cases III and IV kindly illustrated and described by Dr. M. L. Emerson as a most helpful portion of this article illustrate two compound comminuted tibias operated by us. These bolts naturally are trimmed off flush and smooth and leave no rough projections or irritating spicules. In the tibia particularly is this simplicity welcome, for in many cases such apposition cannot be had with wire or even with several plates, and metal screws and bolts necessarily leave projecting heads which in this position particularly are undesirable.

Preparation of compound cases. For twelve years I have treated compound fractures by surrounding the foot (if a leg) in an alcohol compress and tying over this a sterile rubber bag. The leg with the foot now excluded is thoroughly immersed or irrigated for one hour with a fairly strong solution of zinc permanganate or potassium. Early and very early operation seems to be more widespread; in all cases this has been routine with me, and, in view of the uniformly happy results even with plates, I am led to the belief that such treatment negligibly retards bone growth if at all—and the fact is self-evident that gentle extrusion of fractured ends and gentle opening of the traumatized area with thorough submersion or irrigation and removal of free spicules and long unnourished shreds, gives

access to our bacterial inhibiting solutions, and I shall believe that no mere skin preparation or dabbing around with sponges of picric, or iodine or all of them will effectually reach the intricate recesses of our mangled wounds, nor the spongy microscopic surfaces of our bone ends.

I take pleasure in expressing my gratitude for the great help and encouragement shown me by Dr. S. H. Buteau, Dr. M. L. Emerson, Dr. Theo. Olmstead and Dr. W. E. Mitchell, of Oakland, Professor H. M. Evans, of the University of California, Professor F. E. Blaisdell, of Stanford University, and Dr. G. A. Weyer, of San Francisco.

NOTE ON THE USE OF AUTOGENOUS BONE GRAFTS, SECURED AND APPLIED AFTER THE METHOD OF BELL

By Mark Lewis Emerson, M.D.
of Oakland, Cal.

It has been demonstrated that if our operative technic is correct, we can approach bone tissue with the same degree of confidence that we can any other tissue of the body. The manner of approach to the great variety of bone lesions is far from being settled. The Albee cortical graft, the intermedullary graft extensively used and advised by Davison and Smith, and more recently the Bell graft, seem to offer the most promising results. The Albee graft is often taken from another bone, or is held in place by chromic gut or kangaroo tendon, and of itself is not supposed to act as a fixation splint, as it will fracture under strain. The intermedullary graft is not a true graft, as it is more of a bone plug, wherein compact bony tissue is placed in the medullary cavity, thereby supporting the fragments while union takes place. The Bell graft brings compact tissue to compact tissue; it is a true graft as well as a splendid mechanical support. It takes the graft from the site of fracture or from the fragments. There is generally plenty of graft material at hand; one or a half dozen grafts several inches long can be obtained from the average fracture in long bones, and these can be applied to prevent misalignment and rotation according to the mechanical ingenuity of the operator. No suturing or fixing of the grafts is necessary, as they mechanically fix themselves.

Associated with Doctors Bell and W. E. Mitchell we have been using the necessary material offered for this type of bone work at the anatomical laboratory of the University of California, where we have attempted the mechanical fixation of various types of difficult fractures presented at Merritt Hospital, by the Bell method. X-ray prints of fractures were taken, and by the aid of hand and motor saws and chisels the fractures were reproduced on the cadaver. The grafts were then made and applied and various tests given as to the strength of the grafts and their ability to maintain the fragments in place after a certain amount of strain and traumatism. A more technical description of these tests, as well as the application of the Bell graft to the more complicated fractures, will be the subject of another paper.

Whether the keel of the tibia is used for an Albee graft or a section of the fibula for a medullary dowel, this of itself is quite a procedure, as this often takes half of the operative time, and is occasionally followed by complications, such as fracture of the tibia, periostitis and infection. This latter procedure is eliminated in the great majority of cases treated

by the Bell method, and I present for your examination sections of the long bones, so that you may observe the extent of the compact tissue. If the graft itself contains 60 per cent. of compact tissue and is placed within 60 per cent. of compact tissue, it is sufficient for its use, as the cancellous tissue in close proximity of the compact tissue has a certain valuable strength for this type of work. The living cancellous tissue is capable of holding a thread, but a peg entirely of cancellous tissue is of itself too weak. There may be certain value in cancellous bone from a physiological standpoint; it is absorbed and replaced quicker than compact bone. Its value as a filler for cavities, dead spaces and ununited fractures is being worked out by certain operators. V-shaped pieces of semicancellous bone taken from the great trochanter of the femur or tuberosities of the tibia and placed between the ununited fracture of the neck of the femur, is a feature used instead of the Albee peg of compact tissue taken from the tibia. Reconstruction work about the face, or a templet of the lower jaw made out of one or two ribs, could be easily constructed by the Bell method. As a general rule all the graft necessary can be taken from the end of either fragment at the site of fracture.

The small bones of the forearm, when both are fractured and displaced, can be readily held in place by this method as well as in clavicle. Os calcis, astragalus, patella, sacro-iliac joint and displaced tuberosities, have all been experimented upon with apparently ideal results, in the anatomical laboratory.

THE TREATMENT OF ACUTE GASTROMESENTERIC ILEUS

By Albert Paul Condon, M.D.
of Omaha, Neb.

Gastromesenteric ileus is an obstruction of the upper part of the gastro-intestinal tract due to a compression of the terminal duodenum. This compression is brought about by the small intestines sagging into the pelvis, producing a pull upon the root of the mesentery, this in turn compressing the duodenum so that its lumen becomes obliterated. The passage of duodenal contents is stopped, but the circulation of the bowel rarely, if ever, is interfered with.

I am aware that there are other conditions in which there is a dilatation of the stomach, in which the compression by the mesentery of the small intestines is not the cause. But, in this paper I am confining my remarks to that distinct morbid entity in which the duodenum is compressed by the root of the mesentery of the small intestines.

Much has been written in the past twenty years in regard to dilatation of the stomach occurring under various conditions, and the controversy has been heated as to what part the mesenteric pull plays in causing this condition, if any.

I do not know what percentage of the instances of postoperative dilated stomach is due to this gastromesenteric pull, or how much to other conditions, but I do know that a pull upon the mesentery is a frequent cause, as I have on six different occasions, four times at operation and two at autopsy, found the duodenum firmly compressed and its lumen obliterated by the root of the mesentery. In all the patients I have operated or seen at autopsy the stomach and duodenum were greatly dilated, the intestines below the obstruction empty and having the appearance usually found distal to an obstruction.

Clinically, one can usually differentiate a gastromesenteric ileus and a dilated stomach from other causes. The most important differential point is, that in a gastromesenteric ileus the distention is in the stomach and duodenum, the rest of the intestines being collapsed, so that a gastric lavage not only reduces all of the distention, but renders the abdomen scaphoid.

When there is a dilated stomach due to disturbed innervation or other causes, one gets more or less distention of all the intestines. A gastric lavage will reduce the distention some, but not entirely, and the coils of small intestines can usually be made out against the abdominal wall.

Rokitansky, the Vienna pathologist, in 1842, was probably the first to describe gastromesenteric ileus and to give as the cause the constriction of the duodenum by the root of the mesentery.

This condition is usually thought to occur more frequently after

abdominal operations, but our experience has been that it happens just about as often following other operations and in diseases requiring long confinement in bed. We have seen several instances of gastromesenteric ileus after kidney fixation, one after amputation of the leg, one following a mastoid operation. We have also observed it in two patients who had had no operation.

This form of obstruction is noticed frequently in a slight degree, producing just a partial occlusion, giving rise to the so-called chronic gastromesenteric ileus, for which several operations have been tried with success. I might just mention the resection of the ascending colon, and duodenojejunostomy.

Acute gastromesenteric ileus is a complete obstruction and, unless promptly relieved, ends fatally. We are all aware that the higher up in gastro-intestinal tract the obstruction is situated the quicker death ensues, due to the reabsorption of poisons secreted by the patient himself.

Death usually occurs in from thirty-six hours to three days, following obstruction in the duodenum or upper part of the jejunum. On the other hand, I have seen patients with a complete obstruction of the large intestine in good shape after ten days' time. Before we began the use of the treatment that I am going to describe, this form of ileus was our most dreaded postoperative complication.

Five years ago Newell reported, before the Douglas County Medical Society, the postoperative deaths occurring in the Nicholas Senn Hospital for one year. There were 16 deaths and 3 of these were due to gastromesenteric ileus. One we recognized only at autopsy. She had not vomited and was distended very little. The other two were operated upon after failure of frequent lavage and change of position. Both were deeply intoxicated and promptly died.

It is not my intention to discuss the various phases of this disease about which much has been written in recent years. I simply wish to call attention to a method of treatment which has been life saving in our hands and the application of which is simple and rational and in no way harmful.

The usual treatment recommended in this form of acute ileus is: frequent lavage of the stomach and postural methods with a view to altering the position of the intestines, thereby releasing the pull upon the mesentery. If these do not give relief then opening the abdomen and lifting the intestines out of the pelvis and in some cases doing a duodenostomy or duodenojejunostomy.

The postural methods, such as elevating the foot of the bed, etc., we have found of little value, owing to the fact that the peritoneal cavity is a potential one and the change of position does not relieve, to any marked extent, the pull on the mesentery. We had thought of making the peritoneal cavity an absolute instead of a potential one by injecting air into it, thereby making it easier to change the position of the intestines

by elevating the pelvis, but we came to the conclusion that this would not be nearly as efficacious as injecting some fluid intra-abdominally, and then placing the patient in a sitting position. This fluid would then gravitate into the pelvis and displace the intestines upward, and thereby relieve the pull on the mesentery.

This method of treatment occurred to me while operating upon a patient for an intestinal obstruction January 12, 1915. She had the usual signs and symptoms of an ileus when I saw her, twenty-four hours after onset. Upon opening the abdomen the stomach was found enormously dilated, filling the entire abdominal cavity. Elevating the stomach, I found the obstruction to be due to the small intestines being jammed into the true pelvis, pulling upon the mesentery and shutting off the duodenum. After releasing the pull a crease could be seen on the duodenum.

The question then came up how to prevent the intestines from again entering the pelvis and reproducing the obstruction. I thought that by pouring water into the abdomen and filling the pelvis would prevent the possibility of the intestines falling in again, which I did. I then realized that I could have gotten the same results in this patient by injecting a fluid into the peritoneal cavity without having opened the abdomen. I closed the abdomen and emptied the stomach by a gastric tube. She made an uneventful recovery. She continued to occasionally have attacks of a mild degree of obstruction.

On February 6, 1919, a radiographic examination showed a dilatation of the duodenum. I opened the abdomen and found the stomach somewhat enlarged, the duodenum as large as my arm. A duodenojejunostomy was done and she has been well since. I believe in such chronic cases this to be the operation of choice.

Since January, 1915, we have had in the Nicholas Senn Hospital eight well-marked cases of postoperative gastromesenteric ileus, in which the diagnosis was clear. In each case the stomach lavage was resorted to every few hours, and after several washings with no abatement of symptoms the injection of Ringer's solution into the peritoneal cavity was made. Several of these patients were deeply intoxicated. We used from 2000 to 3500 c.c. of the solution and in each instance all of the symptoms were promptly relieved.

In the last case that we had, about two months ago, following a gall-bladder resection, the symptoms were relieved after one injection. They recurred again, however, in three days' time, and we gave a second injection, adding to the 2500 c.c. of Ringer's solution 500 c.c. of glucose, which prevents its rapid absorption.

I think it might be a good plan to add the glucose as a routine measure to prevent the too rapid absorption of the fluid and to help combat the acidosis that is present in these patients.

The technic of the treatment is simple, the instruments necessary are such as are used in an ordinary hypodermoclysis. We make the

point of injection in the midline below the umbilicus, but if an incision has been made here, so that adhesions may be feared, any part of the abdomen may be used.

A small amount of local anæsthesia is injected at the site where the fluid is to be introduced. A medium-sized needle should be selected to make the injection. I use a needle commonly employed for lumbar puncture. It is slowly passed through the abdominal wall by a rotary motion, having the fluid in the needle under some pressure, so if the intestines are against the abdominal wall they will be pushed away by the fluid as the needle enters.

We have found that patients tolerate from 2000 to 3500 c.c. of the liquid before they have distress. After the amount of fluid necessary is injected before removing the needle we inject a few 100 c.c. of air; this latter renders the peritoneal cavity an absolute instead of a potential one, facilitating a change of position of the intestines. We consider such an injection into the peritoneal cavity to be devoid of danger, so much so, that on a number of occasions have used this method to administer physiologic saline solution in preference to giving it subcutaneously or intravenously.

After the injection the patient is placed in as near a sitting position as possible and the stomach lavage continued about every three hours until the stomach secretions become normal.

In conclusion, if we are correct in our conception of the etiology of an acute gastromesenteric ileus, then we are able, by a simple and harmless method to relieve this most dangerous condition of obstruction for a certainty by injecting enough fluid into the abdominal cavity and placing the patient in such a position that it will gravitate into the pelvis. The small intestines must become displaced upwards and thereby relieve the pressure upon the duodenum.

THE NO-FLAP OR GUILLOTINE AMPUTATION *

AN UNFORTUNATE RESURRECTION

By John H. Gibbon, M.D.
of Philadelphia

What I have to say in this brief communication is well epitomized in the title. The method of simply making a circular amputation of an extremity, dividing all the structures, skin, muscle and bone, at the same level, is a resurrection, and what I have seen after these amputations, the frequent secondary hemorrhages, the slow healing extending over months, the painful dressings and the secondary operations which are necessary in nearly all of them, cause me to designate the resurrection as unfortunate.

My first sight of these stumps was at a British base hospital, where we had them in great numbers, and where we were obliged to operate often for secondary hemorrhage, usually from the femoral artery. Repeated hemorrhages occurred in a number of thigh amputations necessitating ligation of the common femoral in many instances.

In spite of the constant irrigation of the wound with solutions, the adherence of the gauze to the raw surfaces, and especially to the exposed nerves, made the dressing for a number of weeks an extremely painful procedure, notwithstanding the fortitude of the British Tommy. All kinds of devices were used to prevent this sticking of the dressings and thus lessen the pain, but none was very successful until the surface had become well covered with granulation tissue.

The application of appliances to draw down the skin, which had already in most instances become fixed at the edges, was itself a painful and troublesome procedure and too often did not succeed sufficiently to obviate the performance of a secondary amputation or a plastic operation.

Because of these dangers and difficulties, it would seem that there must have been some very strong reasons to justify this type of amputation. The justification seemed to rest on these two reasons: that it was life saving, because it was quickly done, especially in the cases of gas gangrene, which was the common cause of amputation in this war, and that it gave a good stump for an artificial limb. For these reasons this method of amputation became quite universal in France, and yet I do not think either or both justified the practice because of the complications already enumerated, and I believe I did and saw enough amputations later where a skin flap was made and reflected to an extent that fully exposed the divided muscles, and where healing was fairly prompt and a good conical stump formed, to prove that the guillotine amputation had no place, or a very limited place, in war surgery. It may be said that the reflected flap method does not obviate the painful dressings and the secondary hemorrhages; but this is not true, for in every

* Read before the American Surgical Association, June 16, 1919.

instance where prompt evacuation or death did not occur, the wound had become sufficiently clean in from four to ten days to permit the bringing down of the flaps, and I can recall no case of secondary hemorrhage after the sterilization of the stump and the approximation of the flaps. The hemorrhages which I saw in the cases of guillotine amputation occurred after the tenth day. The making and the reflection of the flaps occupies but a few minutes and cannot greatly increase the shock. A circular suture passed around the ligated stump of the vessels buries it sufficiently to insure against early hemorrhage. If the flaps are properly reflected, the wound is as wide open as in the guillotine amputation. I employed these reflected flaps in a number of thigh amputations for gas gangrene, first at a British base and later at a Casualty Clearing Station, and in a large part of the American sector still later this method became the rule. My opinion then is not based on theory, but on experience with both types of operation, and it is very fixed that the no-flap amputation is an unfortunate resurrection.

But I have said nothing of the second reason for doing the no-flap operation: namely, that it gives a better stump for the wearing of an artificial leg. All I have to say is that the reflected skin flap amputation gives exactly the same type of stump, but gives it earlier, with less suffering and less danger and, that if it does not, then we must employ the guillotine method in civil practice.

Are we prepared to do it?

TRANSACTIONS

OF THE

PHILADELPHIA ACADEMY OF SURGERY

Stated Meeting held March 13, 1919

DR. G. G. ROSS, Acting-President, in the Chair

SEPARATION OF THE LOWER EPIPHYSIS OF THE FEMUR

DR. HENRY R. WHARTON reported three cases in which the lower epiphysis of the femur had been separated, as follows:

CASE I.—John W., thirteen years of age, was admitted to the Presbyterian Hospital, July 1, 1913, having, twenty-four hours before, fallen from a wagon, injuring the right knee. He was seen by a local physician, who attempted to reduce the deformity at the right knee, under an anæsthetic, but failed. When seen shortly after admission, the region of the right knee was much swollen, and the deformity presented was that of an anterior dislocation of the knee-joint. The joint was fixed in a position of slight flexion, the head of the tibia and epiphysis of the femur being in front of and above the lower end of the shaft of the femur. X-ray examination showed a separation of the lower epiphysis of the femur, the head of the tibia, with attached epiphysis, being in front of the lower end of the femur.

Two attempts, under anæsthesia, were made to reduce the displaced epiphysis without success. The displaced epiphysis then was exposed by a lateral incision on the outer aspect of the knee; this later was supplemented by one on the inner side. A large amount of blood-clot was exposed in the tissues around the seat of injury. By extension and flexion of the knee and the use of an elevator, the epiphysial fragment was with great difficulty restored to its normal position. Fearing a recurrence of the deformity the epiphysis was secured to the diaphysis by a heavy silver wire suture. The wounds were closed without drainage and the limb secured in a posterior splint. Infection of the wound occurred, which required opening of the wound and drainage.

Some days after the reduction had been accomplished it was noticed that the patient had foot-drop, evidently from contusion of the external popliteal nerve. The patient's convalescence was slow, by reason of the wound infection, but he made a good recovery, and when last examined, some three months after the injury, had good motion in knee-joint, aside from slight restriction in flexion. The foot-drop had entirely disappeared.

In this case the reporter said that it was an error to have closed the wounds without drainage, in view of the large amount of blood-clot deposited in the tissues and the contusion of the parts. Fixation of the epiphysis to the diaphysis by suture was unnecessary, as in these cases, when the deformity has been reduced, there is little tendency to its reproduction.

CASE II.—H. D., six years of age, fell down an iron stairway on the Pennsylvania Railroad, and was admitted to the Presbyterian Hospital, March 13, 1918, a short time after the accident. He presented then marked swelling and deformity of the right knee, which on examination proved to be a separation of the lower epiphysis of the right femur, with anterior displacement of the epiphysis and attached head of the tibia. X-ray examination confirmed this diagnosis. The patient was given an anæsthetic, and after somewhat prolonged manipulation the deformity was overcome and the epiphysis restored to its normal position. A moulded binder's board splint was applied to the limb, which extended from the foot to the groin, and in a week, when the swelling had subsided, a plaster-of-Paris splint was applied. The splint was retained for six weeks. After this time passive motion of the knee-joint was practised, and the patient was soon walking without difficulty.

CASE III.—T. G., sixteen years of age, was admitted to the Presbyterian Hospital, July 4, 1918, having a short time before been struck by an automobile, injuring the right knee. The right knee presented a very remarkable deformity. The leg and knee-joint appeared to be drawn inward, while the lower end of the femur above the knee projected outward and was covered by the tightly stretched skin. The rough transverse edge of the lower end of the femur could be felt just under the skin, the injury evidently being an inward lateral displacement of the lower epiphysis of the femur. An X-ray examination showed this to be an inward displacement of the lower epiphysis of the femur, with a limited oblique fracture of the inner edge of the shaft of the femur.

Under anæsthesia by manipulation a fair reduction of the displaced epiphysis was effected. A binder's board splint was applied, extending from the foot to the upper part of the thigh, and when the swelling had subsided at the end of a week, a plaster-of-Paris bandage was substituted. Fixation of the limb was kept up for six weeks, and after this time pasive motion was practised, and the patient was encouraged to use the limb. When seen two months after the accident, he had good motion of the right knee-joint.

Doctor Wharton, in commenting on these cases, said that these three cases of simple separation of the lower epiphysis of the femur are the only examples of this injury that have come under his observation. He had seen a number of cases of compound separation of the lower epiphysis of the femur in which the lower end of the femur lacerated the soft tissues, sometimes the great vessels, and was driven through

the skin. These cases occurred in pre-antiseptic days, and were promptly treated by amputation of the thigh. As he recalled it, the accident usually was observed in boys, who, in attempting to jump on a moving wagon, had the limb caught between the spokes of a revolving wheel. He had no doubt that in these cases at the present time, if the great vessels were not injured, under modern methods of treatment it would have been possible to have had recovery with a useful limb. In all of these cases he had been impressed with the great difficulty in reduction of the displaced epiphysis. In the first case, in which several attempts were made, open operation was resorted to, and even here reduction was very difficult. In examining the X-ray plates for Cases II and III it will be noticed that the reduction of the epiphysis in each case is not perfect, but the functional results are normal.

Dr. A. Bruce Gill raised the question as to the subsequent growth of the bone in cases of separation of the epiphysis in young children. Doctor Haas of San Francisco has published a series of papers on injuries of the epiphysis in relation to the aftergrowth of the bone, claiming that the growth of the bone will be retarded in certain instances. He himself had never seen these cases long enough to know whether separation of the epiphysis in growing children interferes with the development of the bone. In cases of osteomyelitis of the lower end of the radius he had seen deformity develop as the result of defective growth, and likewise in osteomyelitis of the lower end of the tibia.

Dr. Henry R. Wharton, replying to Doctor Gill's question, said that in quite a number of epiphysial separations in children he had not seen much interference with the subsequent growth of the bone. He had seen some cases in which the epiphyses had been destroyed by ostomyelitis and in these there was marked deformity.

MULTIPLE FRACTURE OF THE PELVIS WITH THYROID DISLOCATION, DISLOCATION OF THE RIGHT FEMUR, DISLOCATION OF LEFT ASTRAGALUS, COMPOUND FRACTURE OF RIGHT TIBIA, LACERATED WOUND OF THE LUMBAR REGIONS

Dr. Henry R. Wharton reported the following case:

B. B., twenty-five years of age, a brakeman, was admitted to the Presbyterian Hospital on the night of June 28, 1918. He was caught under a moving freight car and sustained the following injuries: Fracture of a large portion of right ilium, fracture of the right ischium, separation of pubic symphysis, thyroid dislocation of head of right femur, compound dislocation of right astragalus, fracture in lower extremity of left tibia, extensive lacerated wound of skin fascia and muscles of the lumbar region.

The patient on admission was suffering from profound shock, so that temporary dressings only were applied. He was put upon

stimulating treatment, and the next morning still presented the symptoms of profound shock. As he had passed no urine, a catheter was introduced and bloody urine was evacuated. The possibility of rupture of the bladder was considered, but a second catheterization some hours later showed the urine was free from blood, so that the hæmaturia was probably due to contusion of the kidney. As it was considered that he might die at any minute, no attempt was made to reduce the dislocation.

On the third day after admission, as the patient had reacted somewhat, he was etherized and the dislocation of the femur was reduced by manipulation, also that of the left astragalus, and his fractures were dressed. The patient had a slow convalescence. The pelvic fractures were dressed with difficulty on account of the extensive wound in the lumbar region.

He was finally discharged from the hospital October 6, 1918, and is now able to walk quite well, although his gait has been changed by the deformity resulting from the pelvic fractures.

RHINOPHYMA

Dr. John H. Gibbon read a paper with the above title.

EMPYEMA

Dr. John Stewart Rodman read a paper detailing observations in empyema made at Camp Bowie, Texas, for which see page 49.

Dr. John H. Gibbon said that military experience has advanced surgery, especially in the surgery of joints and of the chest. There is nothing about which he could speak more enthusiastically than of the sterilization and closure of the pleural cavity by the use of Dakin's solution. The first discussion he had heard of this work was by Tuffier, who reported 26 cases of infection of the pleural cavity with only four due to pneumonia, the others being due to gunshot wounds. All were sterilized under Dakin's treatment and closed. This should answer any qusetion concerning the efficacy of the Dakin treatment. If one can sterilize the chest cavity and close it regardless of a big dead space underneath, one can say that whatever has been used it is the right method. They found that a great many of these wounds did not need closure but closed themselves. Doctor Rodman did not refer to the fact that a certain proportion of wounds reopen. This does not mean, however, that the wound has not been sterile. They had had gunshot wounds reopen after having been closed for two or three weeks, but the fluid was absolutely sterile in every one. Local anæsthesia should be employed and if the technic is properly developed the operation is not a painful one. When hemorrhage occurs the Dakin's solution has not been properly used. The agent does not encourage hemorrhage. In the American evacuation hospitals they had many large open wounds, but secondary hemorrhage was unusual

because the cases were clean and had been sterilized by Dakin's solution. Secondary hemorrhage is the result of infection.

Dr. D. L. Despard, in connection with the sterilizing power of Dakin's solution, reported a case of long standing, that of a man operated on for empyema eighteen or twenty months prior to coming under his care. The man had a persisting suppurating sinus into which a probe could be passed for six or seven inches; he also had a persistent daily rise in temperature from 99° to 100° every afternoon. The opening was small, but a rubber tube a quarter of an inch in diameter could be inserted into the bottom of the sinus, and the patient, being a druggist, made his own Dakin's solution and injected it himself. In a month the purulent discharge had ceased; the tube was kept in for a week or ten days longer and then removed. He has had no temperature for several weeks and apparently the cavity is entirely closed.

Doctor Rodman said that notwithstanding anæsthesia is regarded as being unsafe in these cases, he had never been able to resect ribs without some pain, even if infiltration and anæsthesia with novocaine were carefully done and the intercostal nerves blocked. Therefore, he had preferred at this stage of the operation light general anæsthesia, preferably using gas-oxygen. Again he agreed with Doctor Gibbon that if the Carrel technic of using Dakin's solution is correctly applied bleeding is not likely to occur—Dakin's solution in the proper concentration (.5 per cent.) will not dissolve healthy tissue, having a selective action on necrotic tissue. If the blood-vessel is necrotic there is no reason to believe that it will escape, but this chance is worth taking for the marked benefit to be derived in getting rid of necrotic tissue and infection in general.

Dichloramine-T has not the solvent effect that Dakin's solution has and for that reason is not as valuable as a sterilizing agent. In his opinion it cannot be compared with Dakin's solution in sterilizing quickly large infected cavities. Dichloramine-T is valuable but chiefly so in small surface wounds.

UNILATERAL TUBERCULOSIS OF THE KIDNEY

Dr. J. Leon Herman (by invitation) read a paper with the above title.

Dr. John H. Gibbon said that one troublesome aspect in renal tuberculosis is that there are cases in which it is difficult to be absolutely sure that there is a good kidney on the other side. About fifteen years ago exposure of both kidneys was urged by Leonard Freeman in doing nephrectomy, to determine whether tuberculosis was present in the supposedly good kidney. In one case operated on twelve years ago in which catheterization of the ureters was not possible both kidneys were exposed, and one found to be perfectly normal. The man made a good recovery and has remained well, except that he had tuberculous necrosis

of costal cartilage two years later. In another patient in whom the testicle had been removed for tuberculosis, blood in the urine led to the suspicion of tuberculosis of the kidney. Operation was not submitted to and the man later had an attack of great pain, passing clots down the ureter. The bladder was opened by suprapubic incision by another surgeon, and in that case there was a question which kidney was involved, although the symptoms clearly pointed to the right side. Repeated attempts to catheterize the ureters failed. There was, therefore, nothing left to be done but to expose the kidneys. This was done, exposing the supposedly good kidney first. A small fluctuating area in this kidney was incised and a stream of tuberculous pus escaped. This little abscess had no connection with the urinary tract. The abscess was excised. The other kidney was removed. This has been five years ago, and, while the man may not be called well, he has never developed tuberculosis of the remaining kidney. The interesting feature about this case is that had they been able to catheterize the ureters they would not have learned of the presence of the abscess found in the supposedly good kidney, which was not indicated in any way. Both of these patients were physicians and both are now carrying on an active practice.

Stated Meeting held April 7, 1919

DR. GEORGE G. ROSS, Acting-President, in the Chair

CERVICAL MENINGOCELE

DR. JOHN STEWART RODMAN presented a case of cervical meningocele which had been relieved by plastic operation.

DR. JOHN B. ROBERTS called attention to the fact that the free flap which Doctor Rodman had used was a graft of fatty fascia from underneath the skin, containing also a portion of tendon of the frontalis above the nose. When the protrusion of cicatricial dura and scar tissue was removed, there was exposed a pit three-quarters of an inch deep with a cranial opening about one inch long and half an inch wide, with the long axis horizontal. Some time ago he took a bone plate out of the girl's tibia and planted it in her right thigh under the fascia lata. This he intends to use later to close the defect in the bone of the cranium, if the tendinous fatty graft recently stitched across the opening fails to prevent protrusion of the cerebral membranes. His idea is to use the fascia lata which was fastened by wire to the bone graft as a patch for the dura mater deficiency.

WAR WOUNDS TREATED WITH DICHLORAMINE-T

DR. PENN G. SKILLERN, JR., read a paper with the above title, for which see vol. lxix, p. 498.

DR. J. STEWART RODMAN said that he had had a rather unusual opportunity to watch the use of dichloramine-T at General Hospital No. 14 during

a term of service of some four months this last year. The use of dichloramine-T was under the supervision of Doctor Lee and in charge of Doctor Furness and, therefore, in the hands of experts. He did not feel that dichloramine-T would ever take the place of Dakin's solution, but that there was a definite field for both. The former did not cleanse the large pus cavities as did Dakin's solution because it has not the solvent action of Dakin's solution. The technic of using dichloramine-T is simpler than that necessary in Dakin's solution. Dichloramine-T was really more valuable in the small wounds than in any other place. In the larger wounds, comminuted infected fractures, etc., dichloramine-T certainly did not do the work that Dakin's solution did.

Dr. Morris Booth Miller said that he had used dichloramine-T throughout the period of our activity in the war. Since September of last year he had seen it used extensively on the wounded soldiers brought back from France. He was entirely convinced that there is no measure which is quite so satisfactory from several standpoints. It is small of bulk, it is easy to apply, it is economical of dressings, it is painless in application, and the quick healing which follows its use, together with these qualities, makes it of great value. Many cases have been brought aboard ship in the last stage of suppuration or of nearly sterile granulation, and they have healed promptly under the use of this measure. There seemed to be no irritation of the healthy skin. Under service conditions they could easily dress 100 cases in one and a half or two hours; the patients made no complaints, especially when it was used in the form of a spray; and the wounds closed with extraordinary rapidity. In the earlier treatment of wounds he thought the Dakin-Carrel solution to be of especial value, but in the terminal stages he knew of nothing to be compared with dichloramine-T.

Dr. John B. Roberts inquired which is better, the dichloramiue-T prepared with the eucalyptol, or with the chlorcozane. He had wondered if he did not get as good results in his face cases with tincture of iodine with equal parts of 95 per cent. alcohol, as with dichloramine-T. He tells his patients not to wash the face where the wounds are. In the past he believed much harm had been done by wetting the sutured wounds of aseptic operations. The circumstances are very different in already infected wounds.

Dr. John H. Gibbon said that this war has taught surgery that the principal object in the treatment of gunshot wounds is their closure. Between 80 and 90 per cent. of all gunshot wounds, particularly if compound fractures are eliminated, can be closed if operated on within ten hours. Such results depend in turn upon the meticulous care with which this is done. The first operation is the most important step in preventing infection of the wound. If the débridement has been properly performed and for some reason the wound is left open, in a large proportion of cases no antiseptic is required. If infection has occurred some chemical agent

must be used. In his opinion there are two criteria by which the efficacy of any agent may be judged: (1) A demonstrated fall in the bacterial count; (2) ability to close that wound by retarded primary or secondary suture. There are thousands of cases that have been thoroughly tabulated showing what can be done with certain agents, particularly Dakin's solution. In the American Army this was used more extensively than any other. It is to be hoped that Doctor Skillern and Doctor Miller will give some figures in regard to primary and secondary sutures done on the bacterial count or on clinical observation. He knew that practically any wound that has been properly débrided, any wound that has been freed of all foreign material and all dead tissue, can be sterilized with the Carrel-Dakin treatment. Any pleural cavity in whch there is no foreign body can be sterilized with Carrel-Dakin solution and closed. If that can be done with dichloramine-T then it ought to be as good as the Carrel-Dakin solution. The care with which the primary operation is done will determine the ease with which the wound is sterilized afterwards if it becomes infected. In one evacuation hospital in the American Army of 500 consecutive wounds, 300 left the hospital with the wounds healed. This, of course, was done in a so-called "quiet period" and not possible in a big battle.

Dr. Moses Behrend: In an experience of nine months with dichloramine-T as a local antiseptic before operation the results have been better than with the application of iodine. In addition to fewer infections it has been shown experimentally that there are fewer adhesions in the abdomen following its use than after iodine. The use of this agent in abdominal work presents a further argument for the employment of this agent.

Dr. George G. Ross had had opportunity to use both dichloramine-T and the Dakin-Carrel solution. Unfortunately, he was not able to give an opinion of their comparative value because he used the Dakin-Carrel treatment at a period of great stress when it was impossible to learn anything of final result. He saw a great many cases in which the Dakin-Carrel solution dissolved out the slough as no other agent he had ever used would. At Brest there were many bad burns in which dichloramine-T was used for a while until obliged to discontinue it because of the intense pain. They then resumed the paraffine or ambrine treatment. In the infected wounds, dichloramine-T proved so satisfactory that they gave up the use of the more complicated method of Dakin-Carrel. It must be said, however, that the type of wounds and the character of the infections were very different from those seen as the result of battle wounds. There was no gas gangrene infection to contend with.

Dr. George M. Laws had an excellent opportunity of comparing dichloramine-T with Carrel-Dakin solution in the treatment of war wounds. During a period of six weeks they were receiving patients at Base Hospital 31 as soon as they could be evacuated after primary opera-

tion performed according to the usual custom, and they had a great many large infected wounds to sterilize preparatory to secondary closure. After using both these agents he was impressed with the superiority of the Carrel-Dakin solution in that type of wound. He agreed, however, with those who advocate the use of dichloramine-T in small wounds and various other types.

Doctor Skillern, closing, replying to Doctor Roberts, said the agent prepared with chlorocazone is what they had on shipboard. It was used by pouring the fluid in and not by spraying; no drain was put in. Referring to Doctor Gibbon's large experience in the Army as compared with the Navy experience, he said that with three or four hundred wounds in various parts of the body and thirty men and three or four surgeons on board, they could not take time to perform débridement, but had to content themselves with simply putting in the dichloramine-T and putting on sterile gauze. Even at the hospital the bacteriological cultures proved sterile. One case was that of compound fracture of the knee-joint and in it there was immediate healing. The fact of not having performed débridement is, I think, a further testimony to the value of this agent.

DERMOID CYST IN RIGHT SUBMAXILLARY REGION

Dr. T. Turner Thomas presented a girl, seventeen years of age, who about three months before coming under observation had experienced some pain in the right submaxillary region, especially on movement, and at this time it was observed that she had a swelling in that locality. Her mother states that at about eleven years of age after an attack of mumps it was noticed that there was a fulness under the chin suggesting double chin, and that this has been present ever since. He saw her first January 21, 1919. He found a non-inflammatory swelling extending downward slightly below the hyoid bone, forward almost to the median line, backward to the sternomastoid muscle and above to the lower border of the jaw. The most prominent portion protruded to about the level of the external surface of the lower jaw. It was not tender but caused a little pain on movement of the head. The skin was freely movable over it and normal in color and feel. On palpation there seemed to be a slight sense of fluctuation.

At University Hospital, January 23, 1919, under nitrous oxide anæsthesia, an aspirating needle withdrew a fluid which looked as though it might have purulent material in it, and an incision about three-quarters of an inch was made about an inch deep and just above the hyoid bone. A finger was then introduced and after it a closed hæmostat, but no pus escaped. The incision was then enlarged outward and upward to about three or four inches and about parallel to the lower border of the jaw. On exposure of the depth of the wound it was first thought we were dealing with a lipoma, but this proved to be the submaxillary gland stretched out over a mass underneath. The gland was separated and retracted

upward, exposing a mass which had a smooth, even surface and seemed cystic. An incision was made into it with the escape of a large quantity of yellowish bodies, suggesting something having the appearance of the so-called melon-seed bodies with the consistency of sebaceous or cheesy tuberculous material. It had very little fluid in it. Each little separate body was soft and easily crushed between the thumb and finger. The bodies varied in size from that of a pin head to an ordinary large bean. The total quantity could not be determined but it was probably between a half pint and a pint. The finger introduced into the cavity found it very deep and smoothly lined with no indication of inflammatory thickening. The surrounding tissues had a normal feel, *i.e.*, they were of normal softness and mobility. The tissue between the depth of the cavity and the pharynx must have been very thin, because it was at first thought the end of the finger was in the oropharynx and against the back of the tongue which could be distinctly felt. At this period of the operation the patient was vomiting and it was thought some of the cavity contents were coming from the mouth, but this was easily found to be not so. Neither did any vomitus appear in the wound.

As the diagnosis had not been made before operation the question of treatment now became very disturbing. It was evident that we were dealing with a cyst and that the contents represented the secretion of the cyst wall. The best treatment of these cysts is to remove the cyst wall, but this would have been a very formidable operation in view of the extent, depth and attachments of the cyst wall to the pharyngeal wall and in the region of the great blood-vessels and nerves inside of and under the jaw. Marsupialization in cysts of the pancreas has been very successful and he concluded to apply this method of operation in this case. The wound was closed to the lower angle by a subcutaneous catgut suture and the edges of the opening in the cyst were sutured to those of the skin at this lower angle. A rubber drainage tube was introduced about two and a half inches and fixed there by a skin suture, and a dressing and bandage were applied. Three days after operation the tube was removed about three-quarters of an inch and entirely in two weeks. The discharge gradually decreased, remained very slight for several weeks and disappeared entirely three weeks ago.

A small section of the cyst wall in the circumference of the opening in it was removed for histological examination together with several of the small caseous bodies found in the cyst. They were studied in the pathological laboratory of the University of Pennsylvania by Dr. F. D. Weidman, who reports as follows:

A section of the specimen of the cyst wall " shows a distinctly squamous lining underlaid by a dense fibrous tissue. The epithelium is of the type seen in skin rather than in the mucous membrane, the basal cells showing nuclei which extend perpendicularly to the basement membrane, the surface ones showing very sharply an arrangement into granular

and keratinous layers. The formation of papillæ is not given. The fibrous tissue below is arranged in collagenous bundles similarly to that seen in the skin, and very frequently bundles of involuntary muscle are met. The individual cells are swollen and degenerate. The feature that clinches the idea that this is skin consists in the presence of several rather large areas of highly vacuolated cells that are distinguishable with difficulty from fatty degeneration in the surface epithelium. Their occurrence, however, below the general level of the surface epithelium and the uniform grade of vacuolization in all of the individual nuclei determines that they are sebaceous. A further diagnostic feature consists in the discovery of two or three delicate (lanugo) hairs which lie within the dilated epithelial lined spaces, immediately adjacent to one of these sebaceous groups, and one of the hairs has a faint yellow tint which is so characteristic of this structure.

"Some of the contents grossly submitted was stained by Soudan III, and even the granular parts assumed a deep orange color which indicates a fatty degeneration. Some was also stained with Van Giesen's stain in an extemporaneous wet specimen, the degenerated cells taking on a green color which changed to yellow when washed in water. This indicates their keratinous nature.

"It appears now very clear that this is a dermoid cyst. The presence of hairs clinches the diagnosis, assisted by the presence of the involuntary muscle which doubtless represents an arrectores pilæ. The sebaceous glands are only less valuable because such are known to occur normally in the mucous membrane of the mouth, and because exaggerations of such very frequently occur in the lips in the condition known as Fordyce's disease. Furthermore, the presence of the granular layer in the surface epithelium is useful because the writer belives that this never occurs in a mucous membrane. The failure of the keratinous papillæ is of no moment because this is usually the case in dermoid cysts. Of the two possible sources of this cyst the writer (Doctor Weidman), therefore, feels certain that it sprang from the skin rather than the mucous membrane and that the lesion belongs to the inclusion dermoids."

Dr. Penn G. Skillern, Jr., said that he could add something of definite interest to Doctor Thomas' case of dermoid cyst in that nine days ago he had almost exactly the same experience in a patient operated upon a year ago for a swelling of the neck. The left submaxillary, salivary and sublingual glands were removed. Five months afterward the swelling came back. There was sudden pain with the swelling. The jaw was not tender but there was present a sense of fluctuation upon pressure. The swelling was pointed up like a frog's belly. The history given by Doctor Thomas of sudden pain beneath the jaw followed by swelling suggested submaxillary salivary calculus.

Dr. Damon B. Pfeiffer said that he had seen pathologically and clinically several cases which correspond closely to the case reported by

Doctor Thomas. It seemed to him that the case can with perfect propriety be regarded as one of bronchial cyst. Such a cyst arises from the inclusion of a portion of an embryonic bronchial cleft and the type of lining epithelium found in one of these cysts is determined by the portion of the cleft which chances to be cut off. Thus, if the included portion of the cleft possesses an ectodermal lining, the resulting cyst will be similarly lined, as in the case under discussion. It is not improper to call this cyst a dermoid or, if you prefer, an epidermoidal cyst, but this does not exclude its bronchiogenic origin.

He recalled a case similar to the one under discussion in which the surgeon merely incised and drained under the impression that he was dealing with a cold abscess. It was necessary subsequently to remove the sac to cure the resulting sinus. It should be remembered that the contents of these cysts vary in character from a clear serous material to a thick grumous or cheesy substance like that found in sebaceous cysts. Of it may resemble very closely the contents of tuberculous abscesses. It is important to make the correct diagnosis at the time of operation since the cyst calls for complete excision and the wound may be closed without drainage. Naturally this rule may require modification in the presence of circumstances such as have just been reported or in the rare event that true infection has been implanted in the cyst.

Dr. Henry R. Wharton said that some years ago he reported before this society three cases of sublingual cyst. The tumors were large and extended down from the hyoid bone. Two occurred in children and one in a woman forty years of age. The microscopic examination showed them to be dermoids. He was surprised at the ease with which they were enucleated, one through an incision in the floor of the mouth beneath the tongue; the other two through an internal incision below the chin extending down to the hyoid bone.

RETROPERITONEAL APPENDIX

Doctor Thomas presented a young colored woman, who was operated on at the Philadelphia General Hospital, July 16, 1918, for appendicitis of mild character. McBurney incision. No adhesions. When the cæcum was pulled out of the abdominal wound and retracted inward, the appendix was seen embedded in the retroperitoneal tissue to the outer side of the cæcum and curled on itself. The peritoneum could be picked up by forceps and easily and freely pulled away from the appendix which continued to lie in its original position. It, therefore, had no mesentery and the overlying peritoneum could be made to slip backward and forward over it by a little pressure of the finger. The peritoneum was cut over the appendix between two forceps, its margins were retracted and the appendix brought into the peritoneal cavity through this opening. Some difficulty was experienced in isolating and grasping the appendicular vessels with hæmostatic forceps and also in ligating and dividing them. The

peritoneal opening was then closed by catgut sutures over the stump of the appendix which was then again in its original retroperitoneal position. Recovery was uninterrupted. Everything seemed to indicate that this was surely a retroperitoneal appendix.

INTUSSUSCEPTION OF HEAD OF CÆCUM WITHOUT INVOLVEMENT OF ILEOCÆCAL VALVE

Doctor Thomas presented, also, a boy, thirteen years old, strong and healthy until present trouble began. Referred by Dr. Geo. E. Shaffer. Admitted to Northeastern Hospital July 10, 1918. On the day before admission he was seized with an abdominal pain and vomiting. The bowels had not moved for two days when on the morning of admission he had a movement which contained macroscopic blood. There was then marked rigidity of the entire abdominal wall with tenderness in the appendiceal region and a diffuse pain around it. Doctor Shaffer had found on palpation a lump between the last rib and McBurney's point. The interne failed to find it, but when the patient was under ether it was again detected. A diagnosis of appendicitis had been made because of the fever and increased pulse, the severe tenderness and abdominal rigidity, the preceding two days constipation, and a possible mass in the appendiceal region. Operation was done soon after admission. McBurney incision. The appendix was located after some difficulty and only in part, the basal portion being concealed in an ill defined mass which exhibited much induration but no adhesions to surrounding tissues. It had little mobility and could not be brought into the wound and the appendix could not be released from its imprisoned position. The ileocæcal junction was not involved in the mass. A higher incision was made along the outer margin of the rectus muscle, extending upward to about two inches of the costal margin. It was still difficult to outline and determine the character of the mass, and, while it was being manipulated, suddenly the appendix was released and the cæcum took its normal form. It now seemed evident that we were dealing with an invagination of the end of the cæcum which had carried in with it that portion to which the appendix was attached. The cæcal wall was much thickened by œdema which also involved the appendix to such a degree that it protruded rigidly through the lower incision. The whole involved portion of intestine including the appendix had a bluish discoloration indicating the probable threatening of a gangrenous process. This rapidly disappeared after the correction of the invagination. The appendix was removed, both wounds closed and healing was uninterrupted.

In the sixth volume of Keen's "System of Surgery," John B. Murphy calls attention to Moschowitz's detailed report of intussuseeption of the appendix, and refers to six more recent cases. He felt satisfied that in this case the intussusception of the appendix was only a part of that of the cæcum. If this condition had continued to progress it could only

have done so by the development of an ordinary ileocæcal intussusception. This case, therefore, may have been only the earliest stage of this common variety of intussusception.

STRANGULATED OBTURATOR HERNIA

Dr. Edward J. Klopp reported the case of a female, age eighty-eight, referred by Doctor Broadbelt, admitted to the Jefferson Hospital January 28, 1919. Four days before admission she was seized suddenly with general abdominal pain. The bowels did not move but had moved on the previous day. The following day she vomited from fifteen to twenty times, the vomitus was dark in color and had a very foul odor. Vomiting continued up to the time of operation. Laxatives and enemas were used freely without effect. On examination the patient presented nothing noteworthy except a mitral systolic murmur and marked arteriosclerosis. The abdomen was moderately distended, no engorgement of the superficial veins, tympanitic and soft throughout, tenderness over both lower quadrants and no abnormal masses palpated. No evidence of hernia in the inguinal, femoral, or umbilical regions. Vaginal and rectal examinations revealed nothing of importance. Temperature, normal; pulse, 100; respiration, 24. Diagnosis: Intestinal obstruction, cause unknown.

The patient was operated upon immediately under nitrous oxide and oxygen anæsthesia. The abdomen was opened through a median incision below the umbilicus. A portion of distended small bowel came into view, it was engorged, œdematous, and dark red in color. After following this bowel in the direction of most congestion the obstruction was found in the right obturator foramen. By gentle traction the strangulated loop was drawn out, which comprised an inch and a half of bowel. The hernial sac was removed and the ring closed with chromicized catgut sutures. The abdomen was closed without drainage.

There were two spontaneous bowel movements within twelve hours after the operation, and one or more movements every day thereafter. She vomited on the seventh day following the administration of a Seidlitz powder. She was out of bed on the tenth day. Everything seemed to go well until the night of the eleventh day when there was sudden collapse, and death in two hours. No autopsy was done, but we had no reason to think that obstruction had recurred.

SARCOMA OF SCIATIC NERVE

Dr. Edward J. Klopp reported the case of a male, age eighteen, who was admitted to Doctor Stewart's service, Jefferson Hospital, May 31, 1917. He complained of a painful swelling on the posterior aspect of the thigh. No acute illness since childhood except typhoid fever at ten; no venereal disease and no history of injury. Two months before admission he began to have pain in the left thigh posteriorly radiating down the leg, especially noticed on walking and at times on sitting down. Later the pain became so severe that it was almost impossible for him to walk. About

two weeks after the onset of pain he noticed a swelling on the posterior surface of the thigh. Appetite and digestion fair, bowels constipated. The patient is rather a poorly developed and poorly nourished adult male. General examination is negative. On the left thigh posteriorly, six inches below the gluteal fold, is a hard, irregular, tender mass about three by four inches. It is distinctly outlined, can be moved laterally but not vertically.

On June 1, 1917, under general anæsthesia, an incision was made over the mass in the long axis of the thigh. The long head of the biceps was adherent to or perhaps involved by the growth, hence a portion of the muscle was cross cut above and below, about an inch beyond the growth. After exposing the sciatic nerve it seemed to tunnel the growth. Separation was impossible, therefore the sheath, with probably one-half of the nerve cord, was excised for a distance of two inches. The adductor magnus and the semitendinosus were apparently free. A small wick of gauze was inserted for drainage. He left the hospital eight days after the operation with the wound healed.

Dr. E. D. Funk made the following laboratory report:

"Specimen weighs 180 gms. and measures 13 by 5 by 5 cm. The principal portion is composed of dark red muscle, œdematous and somewhat flabby. Attached to it and surrounded by a grayish, œdematous membrane is an oval mass measuring 5.5 by 4 cm. This tissue is quite resistant, yellowish-gray and incised with resistance. The outer portions of the incised surfaces are porous, somewhat brittle and resemble cartilage. The rest of the tissue is grayish in color, tough and resistant.

"Fixation in Zenker's solution; staining by usual laboratory methods."

Diagnosis.—Osteosarcoma.

Histology.—The section shows only tumor structure which consists of immature bone. The lamellæ stain lightly and contain many osteoblastic cells. The cells within the lacunæ and canaliculi are large and oval or spindle-shaped. Between the strands of immature bone are many irregularly shaped cells, loosely arranged and very vascular.

A month after operation he had pain again. Shortly after this a mass appeared in the region of the scar. He was readmitted to the hospital and on Angust 6, 1917, the growth was removed. The sciatic nerve seemed to be involved as before, the growth was approximately the same size as that of the former operation. The growth, with attached muscle, and the nerve for a distance of four inches, were excised. The wound was closed with silkworm-gut drainage.

On August 11, he received one-fourth minim of Coley's fluid. He had twenty-eight injections representing a total of seventy minims, the maximum dose being four and one-half minims. The injections were given at intervals varying from one to four days.

He received six X-ray treatments under the direction of Doctor Manges.

Dr. E. D. Funk made the following laboratory report: "Specimen is a tumor removed from the left thigh measuring 9.5 by 7 by 4 cm. and weighing 148 gms. Tissue is dark red in color and very firm, having muscle attached. The main tumor mass measures 3.5 cm. in diameter and is the consistency of bone. A small mass attached to one end is of cartilaginous consistency and yellow in color."

Fixation.—Zenker's solution. Usual laboratory staining.

Histology.—Fibrosis is marked, the nerve sheath is thickened. Many of the fibrous cells are embryonic in character. In the intervening tissue are many thick-walled blood-vessels.

Diagnosis.—Fibro-neuroma.

We believe this to have been a case of sarcoma of the sheath of the sciatic nerve, because of the clinical appearance and laboratory findings and because of the prompt recurrence before the nerve was excised.

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ANNALS *of* SURGERY
227-231 S. 6th Street
Philadelphia, Penna.